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Construction of the new Markland Locks and Dam on the Ohio River will replace five outmoded locks and dams with one modern structure. The new facilities will allow faster lockage, faster operation of tow-boats, and sizable reductions in maintenance.

Bethlehem is supplying nearly 8,500 tons of steel sheet piling for cofferdams used in constructing the 1416-ft long dam which extends from the Indiana shore to the locks on the Kentucky side. The dam, a tainter-gate type with piers founded on rock, is being built in three stages. The first stage cofferdam consists of 19 circular cells each 58.89 ft in diameter, with the top of the cells 50 ft above the river bed and the bottom of the cells on bedrock, a total height of 105 ft. Within this area and adjacent to the upstream cells, rectangular braced cofferdams of Z-piling driven to rock insure safe excavation through the 55 ft overburden of sand and gravel for construction of the pier foundations.

The Markland Dam is a project of the U. S. Army Corps of Engineers, Louisville, Ky., District. The dam is a joint venture of J. A. Jones Construction Co. and Charles H. Thompkins Co.

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BETHLEHEM STEEL

BETHLEHEM STEEL

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CIVIL ENGINEERING

NOVEMBER 1960
VOL. 30 • NO. 11

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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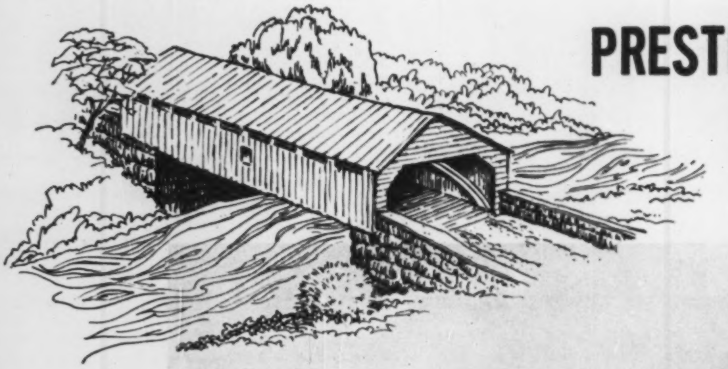
PRESTRESSED CONCRETE

replaces historic covered bridge . . .



Just visible among trees in background is the old bridge, built in 1841, which has now been restricted to pedestrians, equestrians and cyclists. Between the old and the new bridges can be seen a temporary span composed of five 40′ x 3′ prestressed concrete box beams, which was used during life of job for movement of construction equipment.

Each of the 15 prestressed I beams is 74′ long and weighs 22 tons. At the far end of bridge workmen build forms for concrete deck. In addition to the use of Lehigh Early Strength Cement in the beams, Lehigh Portland Cement was used for both deck and piers.

Owner: Pennsylvania State Highway Department

Contractor: Kingston Contracting Company, West Point, Pa.

Prestressed Beams: Eastern Prestressed Concrete Corporation, Line Lexington, Pa.

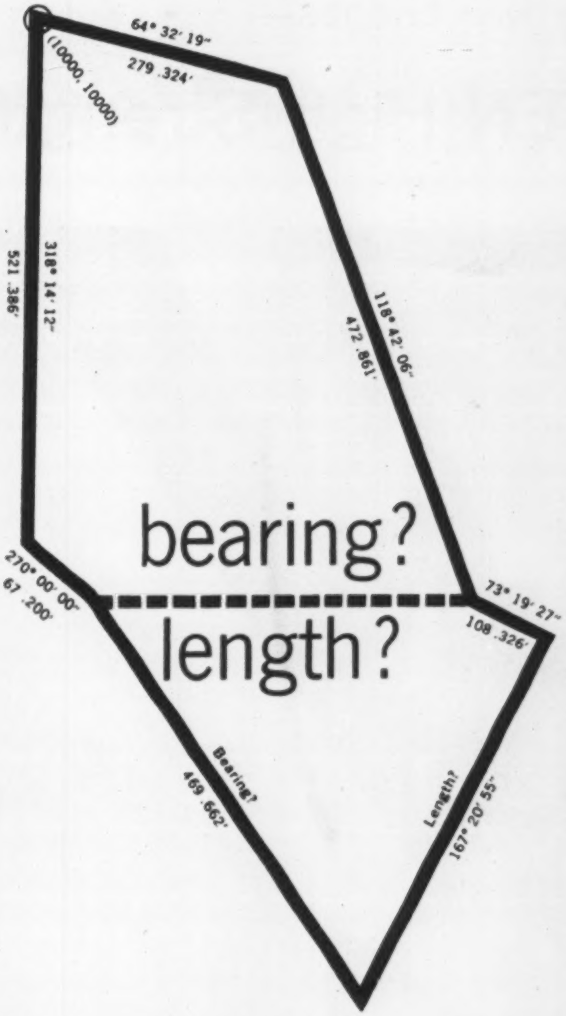
Ready Mix Concrete for Piers and Deck: The Sheesley Company, Allentown, Pa.

● Once again, prestressed concrete has been selected to help ease a problem of increasing traffic. Here, a neat three-span structure replaces a picturesque, but inadequate, covered bridge south of Allentown, Pa. The reasons for the choice of prestressed concrete—appearance, ease of erection, initial cost, low maintenance—explain its growing popularity the country over.

In the manufacture of the prestressed I beams, Eastern Prestressed Concrete Corp. used Lehigh Early Strength Cement. Consistent use of this type of cement in their prestressing operations helps them attain maximum production efficiency through early removal of units and quick re-use of forms.

This is typical of the advantages of Lehigh Early Strength Cement in modern concrete construction. Lehigh Portland Cement Company, Allentown, Pa.

LEHIGH CEMENTS



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it
in
seconds!

Low-cost IBM 1620 Computer frees your engineering staff for more creative work

The low-cost IBM 1620 Engineering Computer solves the traverse problem automatically, in seconds. It also balances the traverse if misclosure is within tolerance. It computes the area within the closed traverse. Versatile and fast, the 1620 can solve interdependent traverse and triangulation problems and many others not directly associated with surveys.

The time saved by the low-cost 1620 in computations like these enables your engineers to spend more time utilizing the results of surveys and less time reducing raw data to usable form.

A readily adaptable survey analysis program has been developed by IBM and will be available without cost later this year. This is another example of Balanced Data Processing, machines supported by a complete range of services. Ask your IBM representative about the advantages of the 1620 and how they can be put to use in your operation. Like all IBM Data Processing equipment, the 1620 may be purchased or leased.

The IBM 1620 is a low-cost, desk-size engineering computer with features previously found only in larger systems. It offers solid state design, magnetic core storage and high-speed internal computing performance. Its versatility and ease of operation recommend it for such engineering applications as highway cut-and-fill calculation, bridge design analysis, earthwork design and many others.

BALANCED DATA PROCESSING **IBM**®

On Erie Thruway twin bridges—

USS MAN-TEN High Strength Steel

USS MAN-TEN Brand High Strength Steel was used for the highly stressed members of these two bridges, including many of the upper and lower chords, diagonals, verticals and gusset plates. Bridge owner: Pennsylvania Department of Highways. Designer: Richardson, Gordon & Associates, Pittsburgh. General Contractor: Brayman Construction Co., Pittsburgh. Erector and Fabricator: The Levinson Steel Co., Pittsburgh.

saves weight and cuts costs

The use of high strength steel as a means of saving weight and reducing costs in bridges is rapidly gaining favor. These twin bridges across Six Mile Creek on the Erie Thruway, 15 miles east of Erie, Pennsylvania, were built with 600 tons of USS MAN-TEN Brand High Strength Steel to ASTM specification A-440 and 1,200 tons of ASTM A-7 Steel.

High strength steel was used for heavily stressed members where its higher allowable stress value and weight savings made it more economical. The design stress in bridges for USS MAN-TEN Steel is usually 24,000 psi compared to 18,000 psi for ASTM A-7 Steel. The members shown in color in the diagram were made of USS MAN-TEN High Strength Steel. In addition, many of the gusset plates were MAN-TEN Steel.

Weight savings: USS MAN-TEN (A-440) Steel fully meets all the requirements of the new ASTM specification A-440. When full advantage of its higher yield point—50% greater than structural carbon steel—is utilized, it allows the engineer to design with smaller sections than would be normally used—and thereby realize weight savings up to 25%. A cost savings is also possible, since anywhere USS MAN-TEN Steel accomplishes a weight reduction over 16%, it then becomes the more economical steel to use.

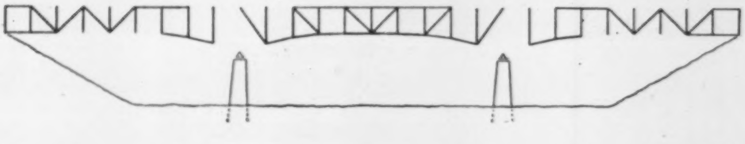
Other USS High Strength Steels available for construction include USS TRI-TEN and USS COR-TEN Steels. Like USS MAN-TEN Steel, these grades have a minimum yield point of 50,000 psi and offer the same weight and a potential cost savings. USS TRI-TEN Steel particularly is recommended for welded structures, while USS COR-TEN Steel, because of its outstanding resistance to atmospheric corrosion and superior paint adherence qualities, is a "natural" for bolted or riveted structures where maintenance is a problem.

Where an extra high yield strength steel is needed, USS "T-1" Constructional Alloy Steel combines weldability and toughness with 100,000 psi minimum yield strength.

For complete information on any of these steels, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS Steels for Bridge Design

Structural Carbon Steel 33,000 psi minimum yield point	**USS MAN-TEN High Strength Steel** 50,000 psi minimum yield point
USS TRI-TEN High Strength Steel 50,000 psi minimum yield point	**USS "T-1" Constructional Alloy Steel** 100,000 psi minimum yield strength



Where high strength steel saved money. Profile of one of the two bridges showing members made of USS MAN-TEN Steel where its high strength/weight ratio made it economical to use.

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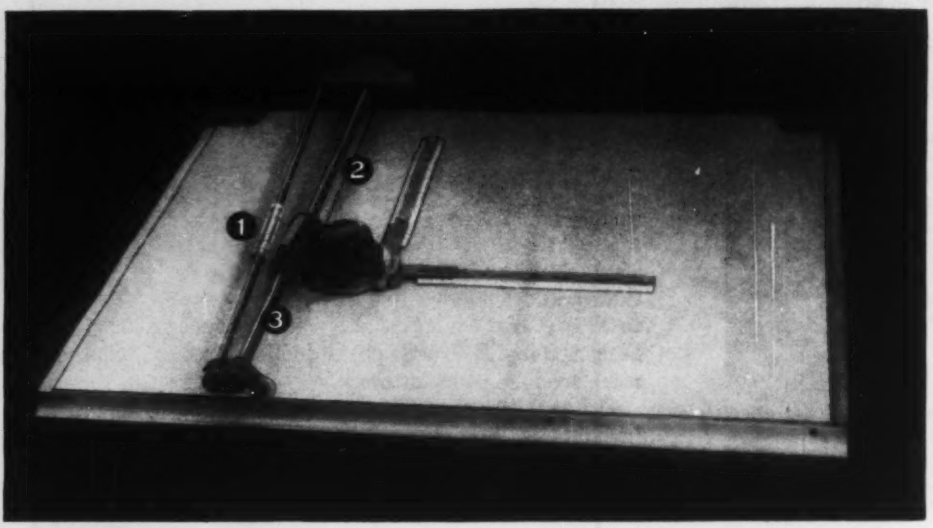

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1. Horizontal positioning lock now centrally located to permit locking or releasing while seated.
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PROVED IN USE

Here are two recent examples of Electrotape efficiency. A crew establishing microwave stations along a 1400-mile pipeline for Pacific Gas & Electric used Electrotape to complete the job in two weeks. San Diego County, California, which is larger than the State of Connecticut, is saving years by using Electrotape in an extensive county-wide surveying and aerial mapping program.

Two identical tripod-mounted Electrotape units are used to measure a given distance. As each unit can be operated by one man, surveying crew expenses are minimized. A radio transmitter and receiver, operating on radar frequencies, and ultra-precise phase-measuring equipment, form the heart of the system.

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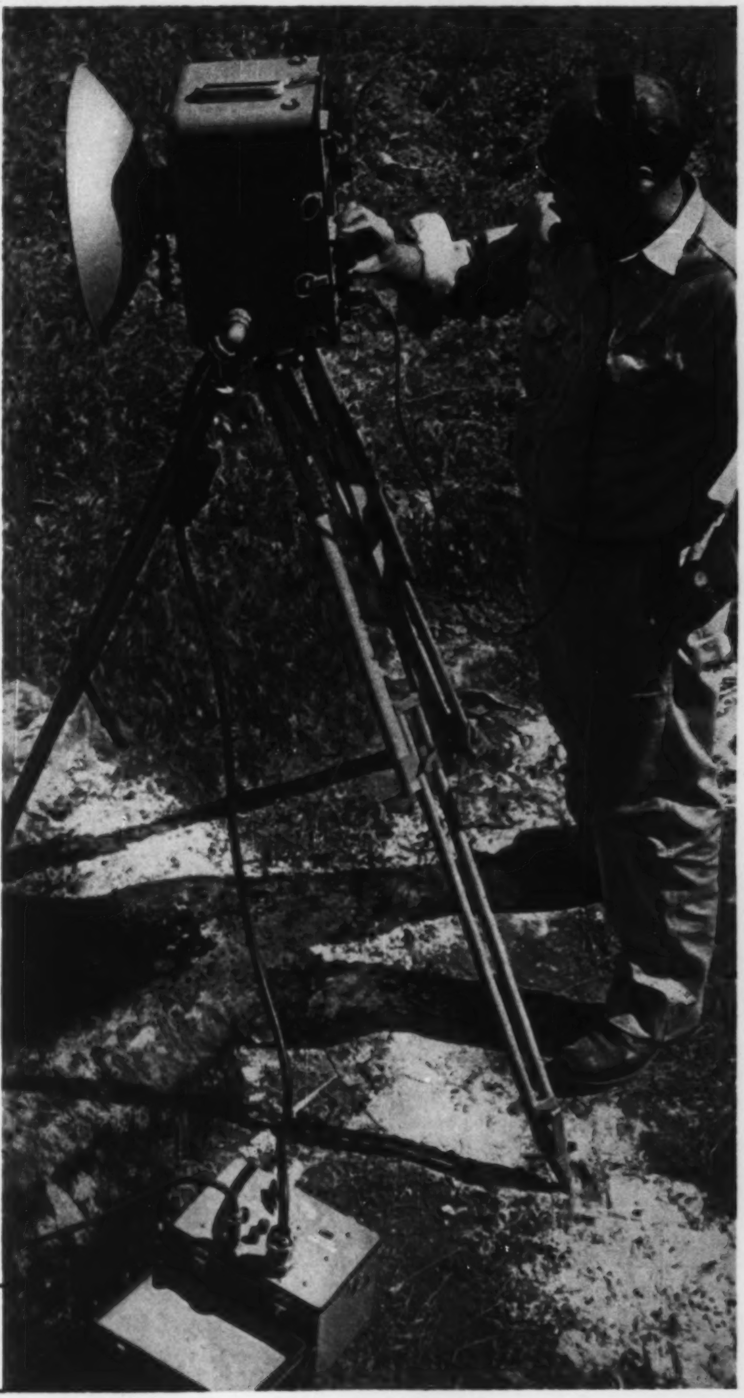
In simplest terms, Electrotape measures the time it takes for a radio wave to travel from one unit to the other and back again. Since the speed that radio waves travel is known, it is then easy to calculate the distance involved. An Electrotape operator requires no knowledge of electronics, and can learn the basic techniques in only 20 minutes. The equipment is lightweight and may be back-packed over rough terrain. A built-in communications link enables the Electrotape operators to converse, for maximum field efficiency.

Savings made possible by Electrotape can easily pay for equipment cost in less than 1 year. Write today for your free copy of a booklet on Electrotape, to Dept. CE-1, Industrial Division, Cubic Corp., San Diego 11, California.



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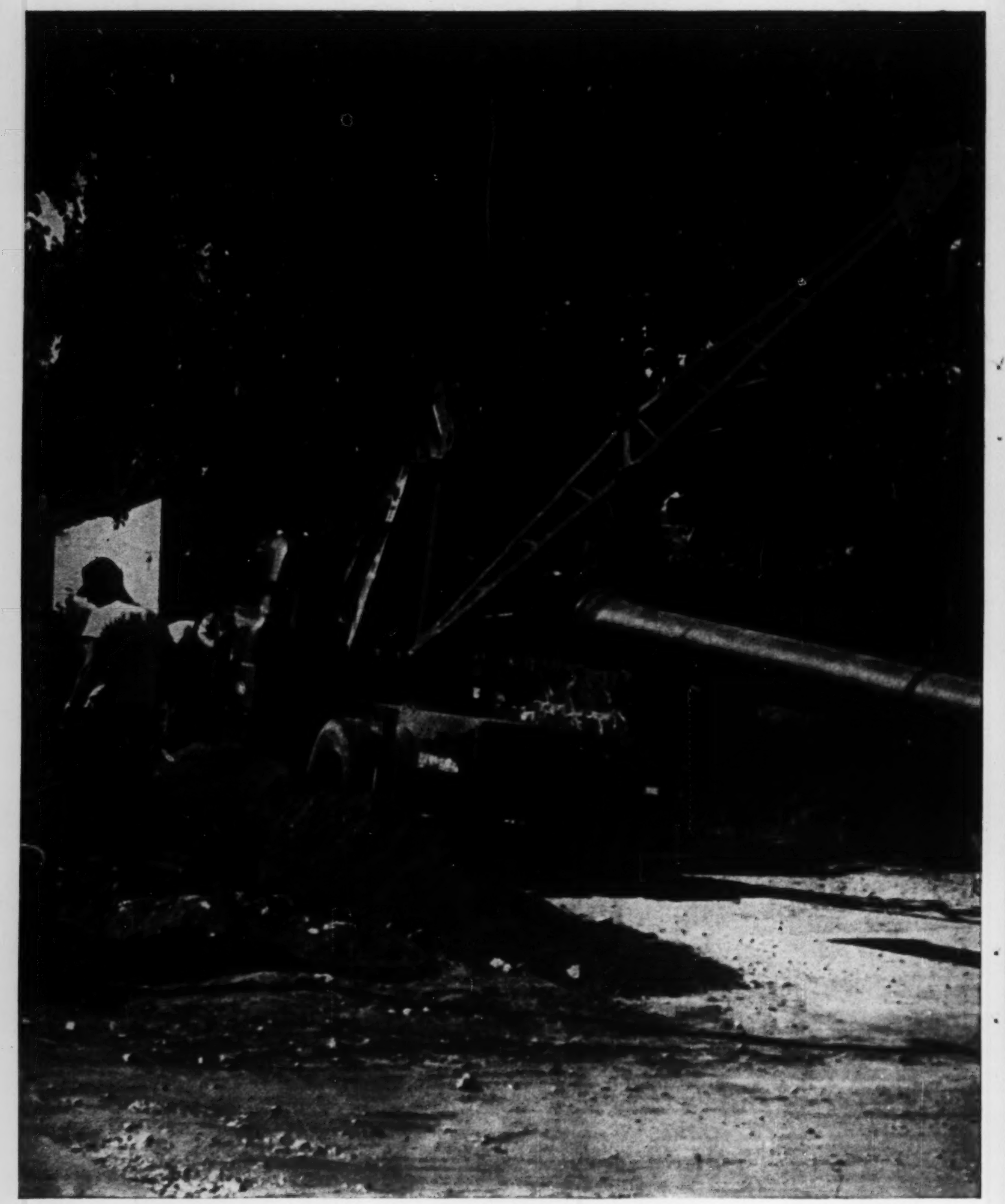

GOES TO BED WITH ITS WORKING CLOTHES ON

From the moment it is installed, cast iron pipe begins working—will deliver its full flow of water for over a century.

Here in Kansas, as part of a major water expansion program, 15,000 feet of cast iron pipe were put to bed. Ease of assembly, bottle-tight joints, and assured full-flow capacity through cement lining were important factors in the selection of cast iron pipe.

An interesting feature was the uncovering of distribution mains constructed of cast iron pipe manufactured in 1887. The pipe was in excellent condition and was put back in water service.

Cast iron pipe is always working. In fact, once it is installed, one can generally anticipate no major repairs or replacements for at least a century.

CAST IRON PIPE RESEARCH ASSOCIATION,
Thos. F. Wolfe, Managing Director,
3440 Prudential Plaza, Chicago 1, Illinois

CAST IRON PIPE
THE MARK OF THE 100-YEAR PIPE

Colorado Department of Highways Colfax-Federal Interchange, Denver, Colorado. A 4-span, continuous "T" girder structure with two roadways 44 ft in width, separated by a 4 ft raised median.

Designers: Ken R. White, Consulting Engineers, Inc., Denver, Colorado
T. V. Stradley, Head of Bridge Section
Contractor: Latimer Construction Company, Denver, Colorado

REINFORCED CONCRETE

continues to hold the line on construction costs

Denver's new Colfax-Federal Interchange, spanning U.S. Highways 36 and 40, is another outstanding example of the greater construction economy possible with reinforced concrete. Over 204 ft in length, this structure was completed at a total cost of only $5.90 per sq ft.

When compared with other construction materials, the over-all cost of reinforced concrete bridges, overpasses, and other highway structures is usually less. On your next project, be sure to consider reinforced concrete. Compare its many costsaving and timesaving advantages.

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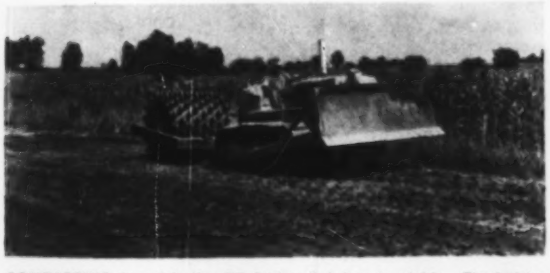
SCRAPER-LOADING using a Caterpillar No. 60 Scraper is a job the new D7 handles with ease. New Turbocharged Cat Diesel delivers 140 HP. Greater torque rise increases its lugging ability 80 per cent.

TRIPLE PLAY BY NEW D7

Three different tasks and 20 per cent more production

DOZING approaches to Eleven Point Bridge, the D7 aerates heavy, wet earth before compacting and adding more fill. New dry-type air cleaner, lifetime lubricated rollers and new transmission lubricating system make low-cost operation normal for a Cat-built Tractor.



COMPACTING is a job the D7 Series D takes in stride. Final drive gears have been strengthened on the new model and big job-proved features have been retained . . . such as the exclusive oil clutch which delivers as many as 2000 service hours without adjustment.

All-around performance—dozing, scraping, compacting—makes the D7 Series D an even better investment than the efficient machine it replaced. On this bridge construction job over the Eleven Point River at Dalton, Ark., the approaches had to be cleared and the road widened. Through heavy, wet sand and clay, the new D7 more than lived up to the expectations of Superintendent Farris Whited, Jr., of the E. E. Barber Construction Company, Fort Smith, Ark.: "The new D7 Series D is the best tractor I have ever operated. It can do at least 20 per cent more work than the former model. It loads the scraper fast and hauls and pulls good. In dozing it can really move the dirt, too!"

Ask your Caterpillar Dealer—who sells, services and maintains a complete parts inventory for a full line of equipment—to demonstrate a new D7. You supply the job and name the date. He'll supply the machine and proof of performance. Call him today.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

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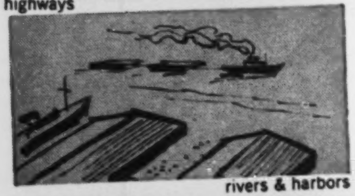
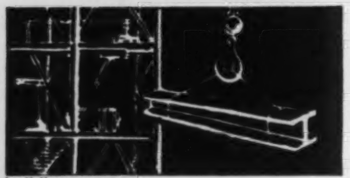

rivers & harbors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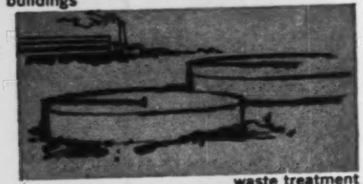
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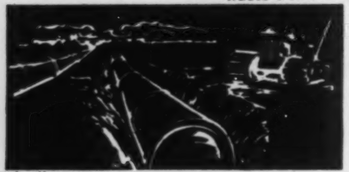
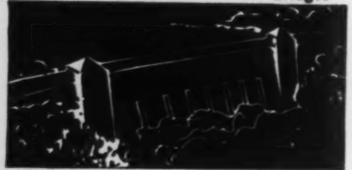
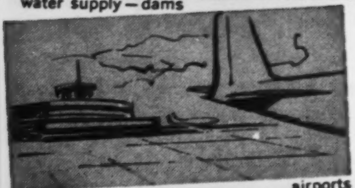

pipelines

bridges


water supply — dams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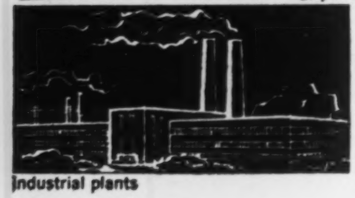
industrial plants

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Civil engineers occupy key positions in each group. Not only are they responsible for design, construction, operation and maintenance "in the field"... civil engineers are also a primary influence "behind the desk," in charge of management.

As a result of this wide responsibility, civil engineers largely control the specification and purchase of construction equipment, materials and services.

The only magazine edited exclusively to serve the technical, business and professional needs of this select audience is CIVIL ENGINEERING... official publication of the American Society of Civil Engineers.

Year after year, its circulation has increased with construction activity and the growth of the civil engineering profession. Editorially CIVIL ENGINEERING serves all areas of construction and all civil engineering interests – making it truly The Magazine of Engineered Construction.

Basic data on the civil engineer's role in different construction industry groups is being furnished by A.S.C.E. Mail Forum surveys. For example, the most recent study (of consulting engineers) revealed these facts:

- CIVIL ENGINEERING's consultant readers own or work for firms that concentrate almost entirely on *engineered construction* projects... with their work divided among the various types of construction as follows:

Airports	3.8%	Military sites	3.9%
Bridges	7.6	Pipe lines	4.6
Buildings, commercial & residential	17.9	Rivers & harbors	1.6
Dams	2.7	Waste treatment	10.9
Highways & streets	14.6	Water supply	10.1
Industrial plants	9.1	Miscellaneous	13.2

- the average annual cost of all the equipment and materials specified by each of the 290 firms reported is well over $6 million.
- 90% of the readers influence the purchase and the specification of construction materials, installed equipment and office equipment.
- their titles and functions are proof of a high degree of authority and a wide area of buying influence within their firms.

In CIVIL ENGINEERING, advertisers reach top quality consultants concerned only with construction. This is the core of your consulting engineer market... the men who specify your products!

And remember... whether your product is specified and purchased through consultants, contractors, architects, owners, public works officials (or any combination of these groups) you get the *most effective, most economical* coverage of civil engineers by advertising in CIVIL ENGINEERING Magazine.

Quality circulation guarantees that your product message will be concentrated on men who make the decisions that lead to purchases!... which is why we say, "advertising in CIVIL ENGINEERING stimulates sales in construction markets."

45,000

CIVIL ENGINEERING

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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on this Cement Plant Stairway
with
KERRIGAN
Weldforged
OPEN STEEL TREADS

TWISTED
Cross Bars
ALTERNATE
right and left

When you specify Kerrigan Weldforged grating you get the utmost in underfoot and underwheel safety . . . in addition to its well known economy features. Bearing bars, and cross bars that alternate right and left, are electronically weldforged into inseparable, one-piece units that stand up under the severest kind of punishment.

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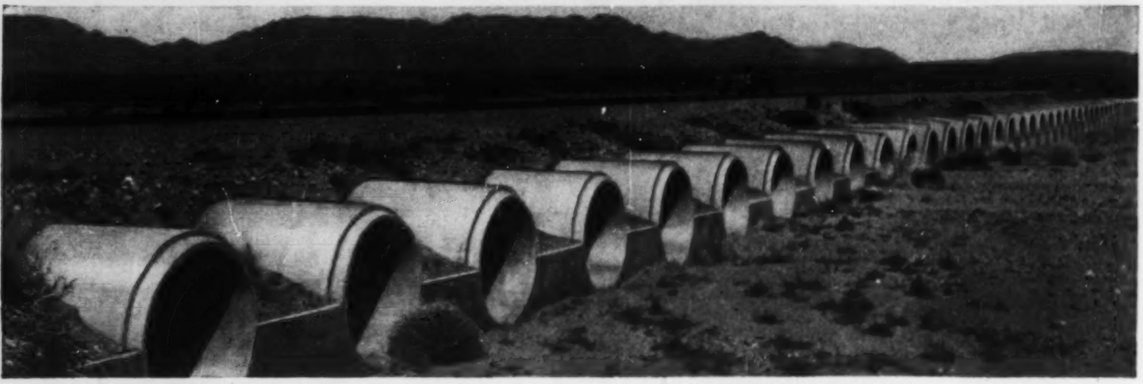
SEVEN CONCRETE WAYS



ROUND PIPE

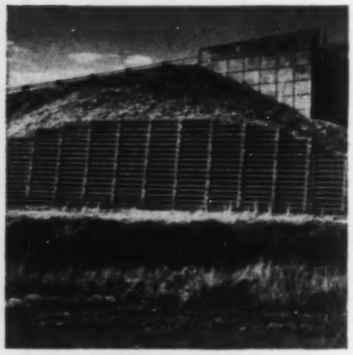
- MINIMUM ENTRANCE LOSS—gives greater capacity, permits smaller diameters
- STRENGTHS PRETESTED—to eliminate guesswork
- SMOOTH INNER SURFACE—provides maximum round pipe hydraulic capacity

HI-HED® PIPE

- 50% STRONGER—on the average than equivalent size round pipe
- SAVES TRENCH WIDTH—in congested areas
- GREATER CAPACITY — than any equivalent size round pipe

American-Marietta offers highway engineers and contractors a related group of seven concrete products—each precast for faster installation at less cost—each designed to do a specific job better.

Expanded manufacturing facilities are located strategically throughout the United States to assure distribution near points of use.



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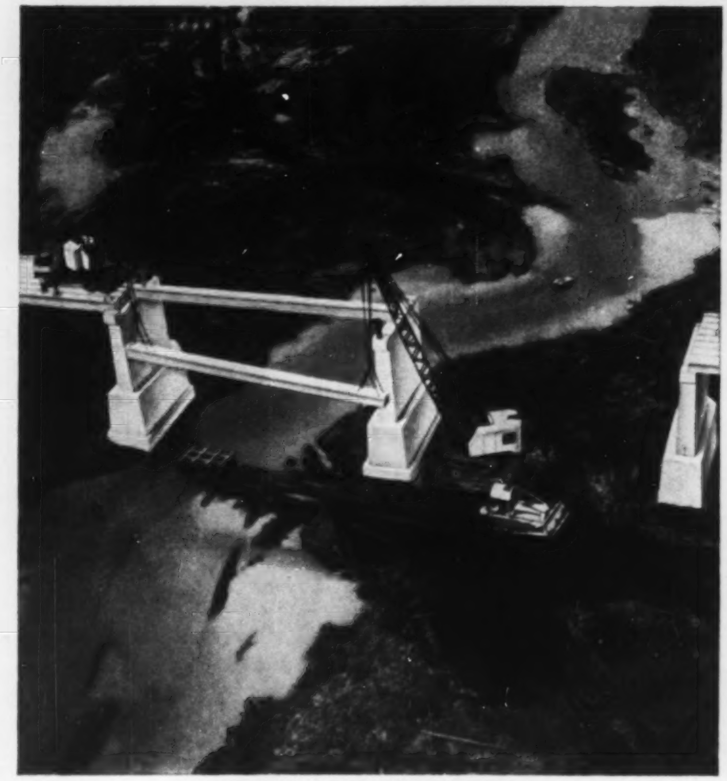
- LONGEST LIFE—stays attractive without maintenance
- FLEXIBLE CONSTRUCTION—unaffected by movement
- EASY TO REMOVE—for relocation

LO-HED® PIPE

- GREATER CAPACITY—two Lo-Hed culverts carry more water than three round pipes of the same height
- MINIMUM DEPTH OF CUT—affords increased cushion of cover
- FASTER INSTALLATION—easier to lay, precasting eliminates bottlenecks

TO CUT HIGHWAY COSTS



BRIDGE BEAMS

- FASTER, EASIER ERECTION—with minimum traffic interruption
- MINIMUM DEPTH-TO-SPAN RATIO—for less weight, greater clearance and reduced fill
- ALL SPAN LENGTHS—precast beams to 35 feet, prestressed Amdek beams up to 100 feet and more
- MINIMUM MAINTENANCE—stays beautiful for years

INNER CIRCLES®

- MINIMUM SURFACE EXCAVATION—pipe passes through pipe *underground*
- OVERHEAD TRAFFIC UNDISTURBED—no weather problem, winter or summer
- LOW COST—no setting of forms or bracing of finished work

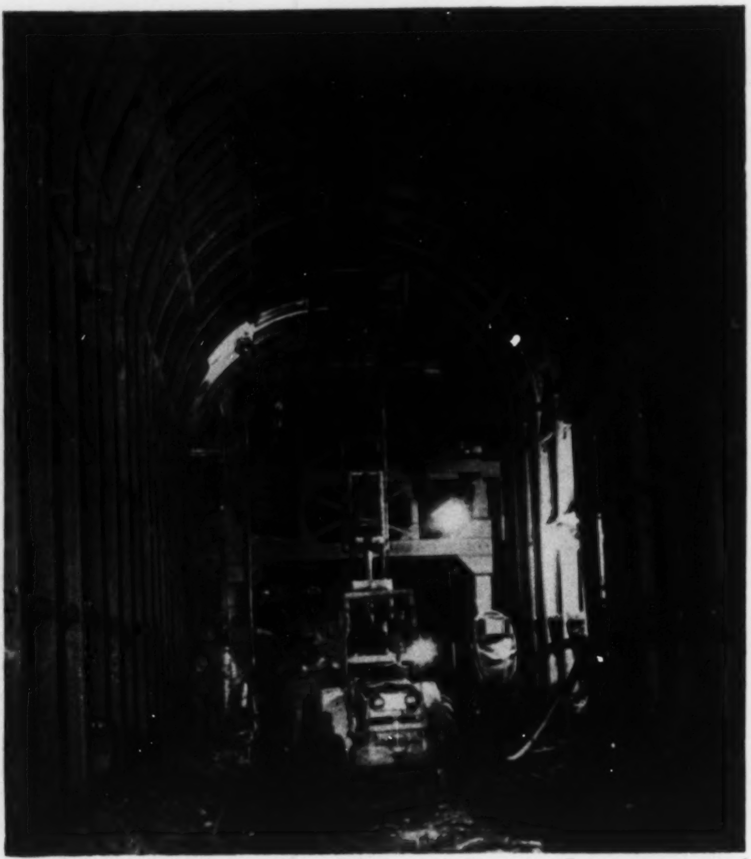
FLAT BASE

- VERSATILE—serves as pedestrian and cattle underpasses, culverts, utility galleries and manholes
- FAST—place and cover 100 feet or more per day. Easy to jack
- ECONOMICAL—saves up to 30% in construction costs

Write for the name of the American-Marietta concrete product plant nearest you. Also, ask for free illustrated literature on any of the products shown on these pages.

AMERICAN-MARIETTA COMPANY
CONCRETE PRODUCTS DIVISION
GENERAL OFFICES:
AMERICAN-MARIETTA BUILDING
101 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS, PHONE: WHITEHALL 4-5600

TUNNEL WORKERS swing into position 8" H-beam side post which supports arch rib.



SETTING STEEL where "bad roof" conditions required spacing Commercial tunnel supports on 4-foot centers.

How to Support a "Bad Roof" Tunnel

The development of an important new source of metallurgical and coking coal was contingent on rail penetration of an almost inaccessible mountain valley.

To reach the 140 million ton bituminous seam in rugged Dickenson County, Virginia, the Norfolk and Western Railway laid a 6.3 mile extension to its Wilder spur. The railway penetrates Sandy Ridge Mountain 800 feet below its 2,730 foot summit with an 8,240 foot tunnel... one of the longest in the East.

Test borings, core-drilled from the top of the mountain to some 17-20 feet below the proposed tunnel floor forewarned of the "bad roof" conditions to be encountered in both headings. Varying thicknesses of unstable gray sandstones, shale, and coal would require tunnel supports designed for quick setting after each mucking operation.

Working closely with Commercial engineers, Norfolk and Western designers specified 8" steel H-beam tunnel arch ribs, bent to proper contour and set on steel posts for the 20-foot by 27-foot bore.

Here's where Commercial's 30 year "know-how" paid extra dividends in safety and speed of job completion. Almost as soon as both headings were started, thin laminated sandstone and coal seams appeared following the roof line for almost the entire length of the tunnel. Thanks, however, to Commercial's accurate fabrication and fast erection design, setting steel progressed rapidly without major mishap to workmen or headings.

A "jumbo" drilling platform was employed to actually handle the steel. One pneumatic hoist mounted on the forward poopdeck swung side posts into place while another hoist on the rear handled the arch rib segments. The sets were then tied together by 1" steel rods and separated by 4" by 4" timbers.

Commercial delivered posts and arch ribs keyed to the job progress schedule, thus helping 'round-the-clock crews drive the face at an average weekly rate of 250 feet including steel setting... progress that was also important to a new local 450,000 kw powerplant dependent on the valley mines for fuel.

When you design your next vertical shaft or sub-surface tunnel, Commercial engineers will be glad to offer assistance based on 30 years specialization in ground and rock support systems. There is no obligation, and their recommendations often result in more workable and economical solutions to specific problems.

For complete information, just write to Commercial Shearing & Stamping Co., Dept. **C-45**, Youngstown 1, Ohio.

COMMERCIAL
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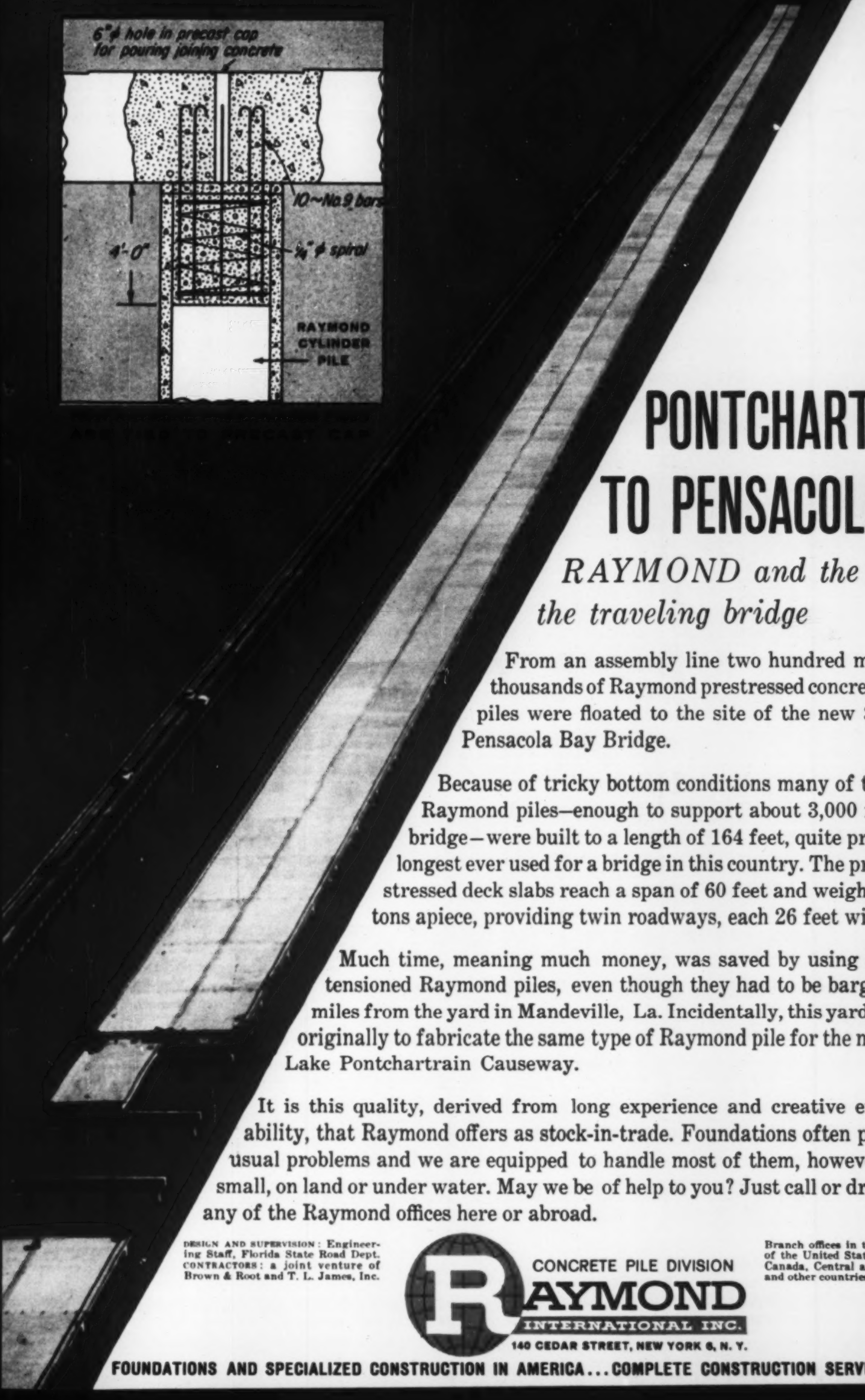


[illegible] ARE TIED TO PRECAST CAP

PONTCHARTRAIN TO PENSACOLA:

RAYMOND and the case of the traveling bridge

From an assembly line two hundred miles away, thousands of Raymond prestressed concrete cylinder piles were floated to the site of the new $8,000,000 Pensacola Bay Bridge.

Because of tricky bottom conditions many of the 54-inch Raymond piles—enough to support about 3,000 feet of the bridge—were built to a length of 164 feet, quite probably the longest ever used for a bridge in this country. The precast, prestressed deck slabs reach a span of 60 feet and weigh about 156 tons apiece, providing twin roadways, each 26 feet wide.

Much time, meaning much money, was saved by using these post-tensioned Raymond piles, even though they had to be barged for 200 miles from the yard in Mandeville, La. Incidentally, this yard was set up originally to fabricate the same type of Raymond pile for the magnificent Lake Pontchartrain Causeway.

It is this quality, derived from long experience and creative engineering ability, that Raymond offers as stock-in-trade. Foundations often present unusual problems and we are equipped to handle most of them, however large or small, on land or under water. May we be of help to you? Just call or drop a line to any of the Raymond offices here or abroad.

DESIGN AND SUPERVISION: Engineering Staff, Florida State Road Dept.
CONTRACTORS: a joint venture of Brown & Root and T. L. James, Inc.

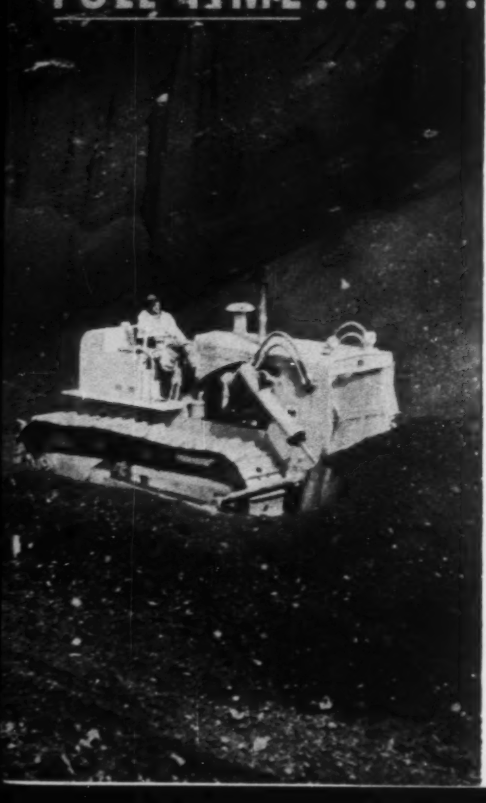
CONCRETE PILE DIVISION
RAYMOND
INTERNATIONAL INC.
140 CEDAR STREET, NEW YORK 6, N. Y.

Branch offices in the principal cities of the United States. Subsidiaries in Canada, Central and South America and other countries around the world.

FOUNDATIONS AND SPECIALIZED CONSTRUCTION IN AMERICA . . . COMPLETE CONSTRUCTION SERVICES ABROAD

WITH FULL-LOAD PERFORMANCE FULL TIME......

Planet Power-steered..Hi-Lo outblade clutch-steered



With exclusive "live track" Planet Power-steering, the International TD-25 makes full-load, full-power turns—or slams straight ahead with offset loads—where giant clutch-steered rigs slip and slue. With exclusive Hi-Lo, on-the-go power-shifting, the "25" gives you instant cut-to-fill matching of power to condition. You roll up big loads—and keep 'em rolling. With exclusive International DT-817 engine wallop the "25" bulls along, 230 turbocharged hp strong—without "slow-motion" lug-downs, even at high altitudes! Prove to yourself the planet-drive "25" clobbers all comers—outpushes or out-pulls 'em up to 50% —*and with standard equipment.* Let your International Construction Equipment Distributor demonstrate.

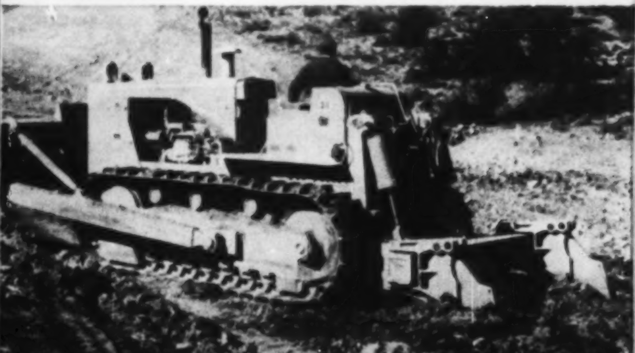
◀ **Dozing volcanic cinders for railroad ballast,** this International TD-25 beats the combined production of two similar-sized clutch steered crawlers on the same job! Reason: Hi-Lo power-shifting gives exclusive 4-speed torque-converter efficiency-range control. The "25" delivers heaped loads every pass! To defy "grinding compound" conditions, the "25" undercarriage has heavy-duty Dura-Rollers.

Even with an enormous offset load of shot rock there's no "bank-nosing," no sluing. The TD-25 operator simply runs the load-side track in high-speed range—the other in low-speed range. Result: full-capacity, straight-ahead performance—which the "25" also gives on benching, bank-cutting, and side-casting! In the same way, you make full-load turns—because Planet Power steering eliminates "dead-track drag!"

With Hi-Lo on-the-go power-shifting you shift down, to dig hard material—shift up, to "run" with the load. And to make full-load turns without spillage, use Planet Power steering: down-shift the turn-side track, and you've got it made! When push-loading with the "25", you maintain solid contact on straight-away or curve—to speed heaping the bowls and get gear-higher "kick-outs"!

power-shifted "25's" crawlers up to 50%!

With the same 2-finger ease as on dozing or push-loading, you steer the TD-25 pulling heaviest drawbar tools. This "25" is deep-ripping "concrete-like" mountain clay that has to be shattered before dozer can move it economically. The "25" has the super undercarriage strength of double-box-beam track frames—for full-capacity performance.



International® Construction Equipment

International Harvester Co.,
180 North Michigan Ave., Chicago 1, Illinois
A COMPLETE POWER PACKAGE

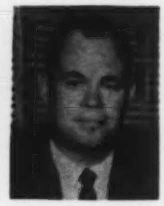
NEWS OF MEMBERS

John A. Miller, engineer, author, and historian, is retiring as publications specialist in the General Engineering Laboratory of the General Electric Company, a position he has held since joining the company in 1945. He will shortly become director of technical publications for the Mohawk Development Service of Schenectady, N. Y. A former editor with the McGraw-Hill Publishing Company, Mr. Miller is author of "Master Builders of Sixty Centuries," an outline history of civil engineering, and other works.

John Saks, a veteran of nearly 35 years with the City of Milwaukee, retired recently as superintendent of street and sewer maintenance, a post he has held since consolidation of the separate bureaus five years ago.

O. W. Israelsen, a widely known irrigation engineer and professor emeritus of the department of civil and irrigation engineering at Utah State University, for the past two months has been conducting a class of postgraduate students at the SEATO Graduate School of Engineering at Lahore, Pakistan. Beginning in November, Dr. Israelsen will also give the short course in irrigation at Bangkok, Thailand.

Warren Travers, an associate of Edwards and Kelcey, engineers and consultants, of Newark, N. J., has been elected president of the New York Metropolitan section of the Institute of Traffic Engineers.



Donald C. Tillman, an engineer with 13 years' experience in helping solve Los Angeles' engineering problems, has been promoted from senior civil engineer in the West San Fernando Valley district office of the bureau of engineering to commissioner on the five-man board of public works. The Board acts as general manager of the city's vast Department of Public Works and its 13 varied bureaus.

A. Frederick Griffin, retired on September 30, after 34 years of service with the Corps of Engineers. As principal civilian assistant to the Upper Mississippi Valley division engineer from 1934 to 1954 and as special engineering consultant to the North Central Division from 1954 until his retirement, Mr. Griffin made major contributions to the development of the modern Upper Mississippi River navigation system and to the design and construction of the St. Lawrence Seaway.

Olin W. Mintzer, associate professor of civil engineering at Ohio State University, recently read his research paper on using airphotos to identify construction sources of gravel before the Ninth International Congress of Photogrammetry at the University of London, England. Mr Mintzer made the point that the use of aerial photographs may determine whether a contractor makes a profit on some highway projects.

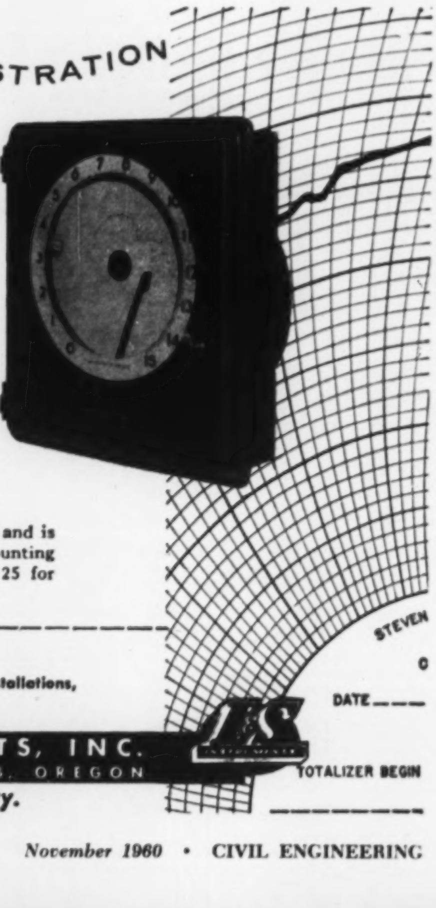
(Continued on page 24)

ACCURATE GRAPHIC AND VISUAL REGISTRATION

of liquid flow with

STEVENS

RECORDER TYPE B-FT



Recording, indicating and totalizing meter for measuring sewage or other flows over Parshall flumes and weirs. This instrument has interchangeable flow cams and flow conversion gears . . . an important factor to consider for sewage treatment plants in rapidly growing communities. With a simple change of cams and gears the Type B-FT Recorder can operate with a different size flume or accommodate a greater range of flow than that for which it was originally purchased. The change does not require factory service. Similarly, change from weekly to daily time scale, or vice versa, is accomplished by merely repositioning one gear — no new parts to buy.

This recorder can be direct float operated or remotely controlled and is available for wall or switchboard mounting, or with cabinet for mounting out of doors directly over the float well. Request BULLETIN 25 for complete details.

STEVENS HYDROGRAPHIC DATA BOOK

Invaluable for your reference file. Contains technical data on recorder installations, plus a wealth of hydraulic and conversion tables. $1 copy. (No COD's)

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Specialists in hydrologic instruments for over half a century.

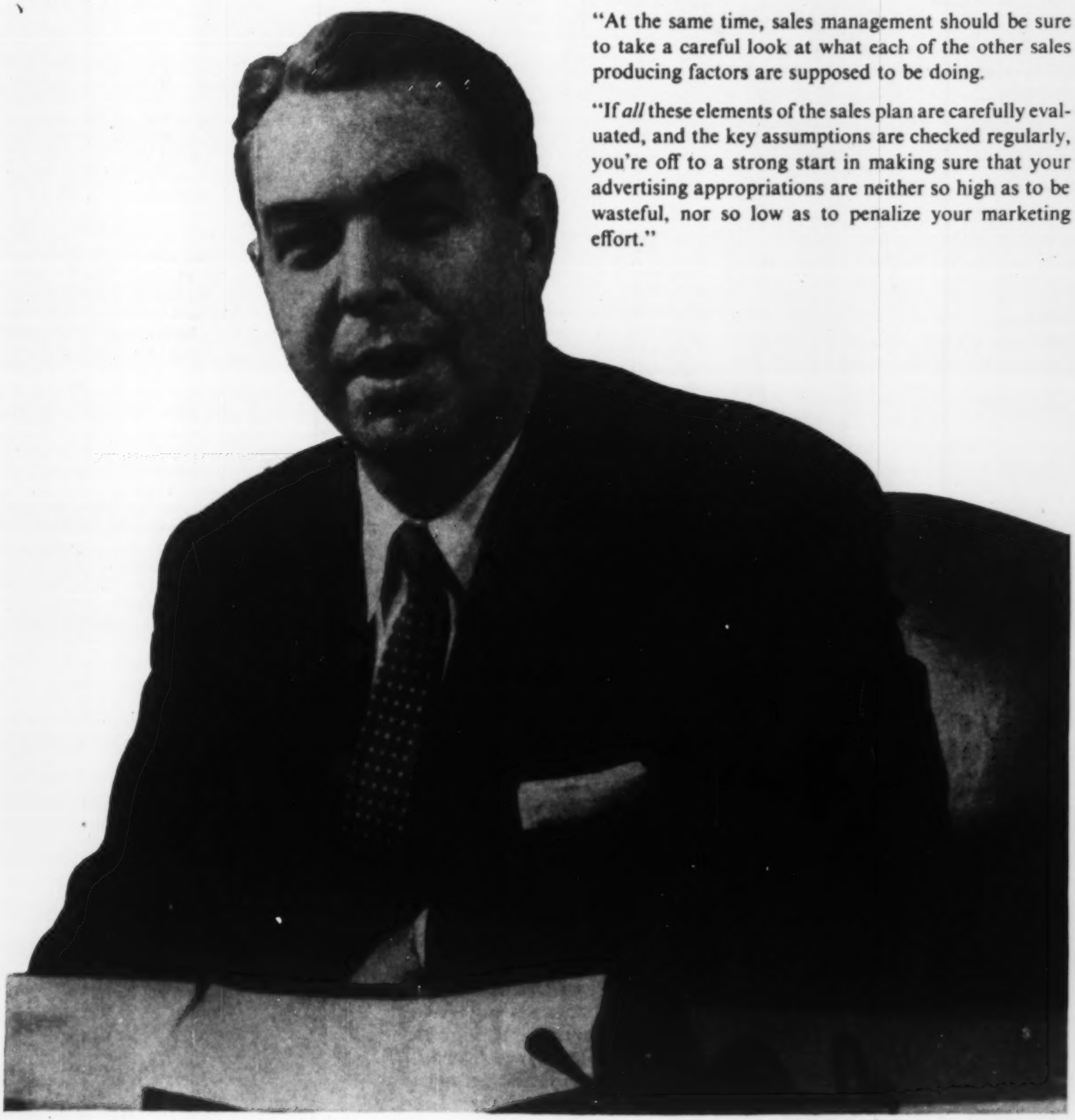
“How much is enough for advertising?”

John R. Sargent, partner in the nationally-known management consultant firm of Cresap, McCormick and Paget, points the way toward solution of one of top management's knottiest problems.

"Good sales management generally knows the crucial sales problems faced by each one of its products. Through good advertising advice plus experience, trial and error, and some judicious advertising testing, sales management also can come to have a good understanding of what advertising can and cannot do.

"At the same time, sales management should be sure to take a careful look at what each of the other sales producing factors are supposed to be doing.

"If *all* these elements of the sales plan are carefully evaluated, and the key assumptions are checked regularly, you're off to a strong start in making sure that your advertising appropriations are neither so high as to be wasteful, nor so low as to penalize your marketing effort."



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Robert H. Meade, Rear Admiral, U. S. Navy (retired), who resigned recently as consulting engineer for the New York City Department of Marine and Aviation, has become a consultant to the New York firm of Parsons, Brinckerhoff, Quade & Douglas. Admiral Meade retired as chief of the Navy's Bureau of Yards and Docks and chief of civil engineers in 1958, after 35 years of service in the Navy Department.

Alan Cohen, until recently soils engineer with Moran, Proctor, Mueser & Rutledge, of New York City, is now vice president in charge of the new offices and soil testing laboratory opened by Joseph S. Ward and Associates, Inc., at 1015 Chestnut Street, Philadelphia. The firm's New Jersey office remains at 91 Roseland Avenue, Caldwell.

Matthew Swain, after 37 years of service in the Army Corps of Engineers, has retired from the position of assistant chief of the engineering division in the Philadelphia District Office.

F. J. Larkin, who started with the Dravo Corporation in 1934, recently was named general superintendent of plant for the firm's Contracting Division. In his new position Mr. Larkin has responsibility for supervision of the Division's multi-million-dollar equipment used in major construction projects throughout the United States.

Ray W. Burgess is Louisiana's new director of the Department of Highways. For the past five years he has been director of public works for the city-parish government at Baton Rouge, and prior to that, was an engineer for the Stone and Webster Engineering Corporation for 13 years.

C. E. Vick, Jr., since receiving his master's degree in civil engineering from North Carolina State College last June, has been engaged in traffic planning for Harland Bartholomew and Associates in St. Louis, Mo. At present Mr. Vick is assistant project engineer on a study being conducted by the firm to ascertain the feasibility of a tunnel project contemplated in Birmingham, Ala.

E. Warren Bowden, executive vice president and a director of Walter Kidde Constructors, Inc., is returning to Houston, where he first established Walter Kidde's operations in the Southwest 12 years ago to take on additional duties as president of the firm's subsidiary, Walter Kidde Engineers Southwest, Inc. As one-time assistant to the chief engineer of the Port of New York Authority, Mr. Bowden was concerned with the engineering and construction of such projects as the George Washington Bridge.

Taylor D. Lewis, head of the department of transportation engineering and professor of civil engineering at Cornell University, has been awarded a Senior Visiting Fellowship by the National Science Foundation for a six-month study of transportation problems at the Road Research Laboratory in England. Professor Lewis will review and appraise the research techniques that affect various methods of transportation.

Gordon R. Williams, after a seven-year absence, has rejoined the New York firm of Tippetts-Abbett-McCarthy-Stratton as an associate. Mr. Williams served with the firm from 1946 to 1953, when he left to become professor of hydraulic engineering at the Massachusetts Institute of Technology.

Patrick L. DeNaples is the new field engineer for the Portland Cement Association in the Dayton and west central Ohio area. Mr. DeNaples formerly was assistant general manager of Foundation Services, Inc., in Columbus, and soils engineer with G. K. Jewell & Associates.

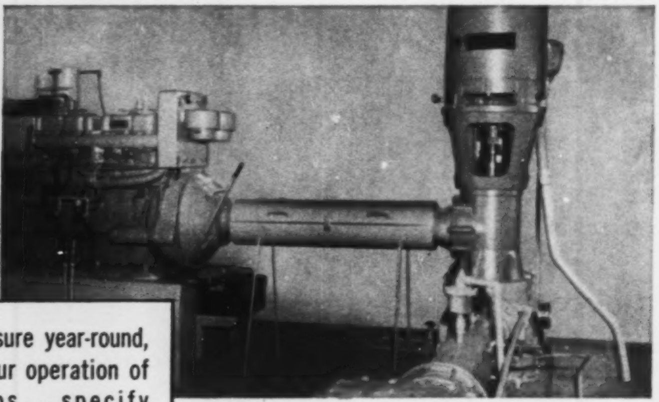
Wade L. Menober and **James Chinn,** associate professors of civil engineering at the University of Colorado, have been promoted to professors of civil engineering. In addition, **Walter A. Weers** has been promoted from assistant professor to associate professor and **Donald G. Leitch** from instructor to assistant professor. **Robert Lee Schuster,** instructor in civil engineering at Purdue University has joined the University of Colorado staff in the capacity of associate professor.

Ming L. Pei, associate professor of civil engineering at the City College of New York, has been granted a leave of absence to serve as visiting associate professor for the fall term at the University of Michigan.

Seng-Lip Lee, a specialist in thin-shell concrete structures, and in the new field of plastic design, has been promoted from associate professor of civil engineering to full professor in the Technological Institute at Northwestern University in Evanston, Ill. Before going to Northwestern in 1955, Dr. Lee was a structural engineer with the Bechtel Corporation of San Francisco. Another faculty member, **O. C. Zienkiewicz,** was also named full professor of civil engineering. Dr. Zienkiewicz has an international reputation in the field of large dam construction and structural model work.

Seng-Lip-Lee

O. C. Zienkiewicz



To insure year-round, 24-hour operation of pumps . . . specify

JOHNSON *Right angle* GEAR DRIVES

Protects water supply, sewage and flood control operations against power failures; also permits overhauling electric motor or power unit without interrupting service. Thousands in use by municipalities, industry and farmers. Available in turbine or engine driven combination drive (as shown here), standard and dual types, with either hollow or solid shaft. Sizes: 15 to 450 hp. Write now for engineering catalogs.

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GEAR & MANUFACTURING CO., LTD.
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East and Gulf Coast representatives:
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James B. Ramsey, until recently chief engineer and superintendent of the Water Department of Kansas City (Mo.), has been named assistant secretary of the American Water Works Association. Mr. Ramsey's professional contributions during 20 years' service to the Water Department earned him the "Award of Merit" of the Missouri Water and Sewage Conference in 1957 and the "George Warren Fuller Award" of the Missouri Section of AWWA in 1959.

R. O. Grimes, who went to Richland, Wash., in 1959, as chief engineer to help administer and staff a branch office for the Houston firm of H. E. Bovay, Jr., and to provide engineering services under a contract with the Atomic Energy Commission, has resumed his former position as associate of the Bovay organization in Houston as well as his duties as senior project engineer. He will also serve as assistant projects manager to Charles A. Lawler, a partner in Bovay.

Donald A. Leach, after nearly 40 years of service with the Chicago Bridge & Iron Company, retired recently as vice president and regional sales manager. However, he will retain his connection as a director of the company.

C. George Dandrow, vice president of customer relations with the Johns-Manville Sales Corporation, has accepted the New York area chairmanship of the $66,000,000 Second Century Fund program of his alma mater the Massachusetts Institute of Technology.

W. Keith Boyd, since 1953 chief of the Applied Research Branch of the Army's Snow Ice and Permafrost Research Establishment at Wilmette, Ill., has been appointed technical director of the organization. Prior to joining SIPRE, Mr. Boyd was in Alaska as materials engineer and assistant construction engineer for the U.S. Bureau of Public Roads.

Donal Devine has resigned his position as senior research engineer with the Republic Aviation Corporation at Farmingdale, N. Y., to accept the post as Smithtown (N. Y.) town engineer. He is a specialist in strain-electrical resistance gage application to complex structures.

Ping C. Wang, after nine years with Seelye, Stevenson, Value and Knecht, New York City, as supervising engineer, is now associate professor of civil engineering at the Stevens Institute of Technology. A native of China, Mr. Wang earned his M.S. degree and doctorate at the University of Illinois.

Fremont H. Jewell has left the Walter Butler Company of St. Paul, Minn., where he was chief structural engineer to join Durox, Inc., in the same city, as chief structural engineer in charge of the firm's engineering department.

(Continued on page 26)

IF
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PROBLEM
IS A
SALES
PROBLEM . . .

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Many members of ASCE have important sales responsibilities in their firms. If *you* are one of them, don't overlook the basic selling power of your own magazine, CIVIL ENGINEERING.

Civil engineers, as you know, are active in all areas of engineered construction. But, in spite of their numerous functions and activities, they have a lifetime interest in their profession . . . and the construction industry! CIVIL ENGINEERING is the *only* magazine published exclusively for civil engineers.

As a reader, you do not need to be reminded of its editorial merits. However, if you are not fully aware of how *advertising* in CIVIL ENGINEERING stimulates sales of construction products and services, let us supply you with the facts.

Just drop a line to:

Jim Norton, Advertising Manager
CIVIL ENGINEERING Magazine
33 West 39th St., New York 18, N. Y.

Paul D. Troxler, recently-retired Colonel and district engineer of the Jacksonville District of the Corps of Engineers (see May 1960 issue), is en route to Lahore, Pakistan, as project manager for Tipton and Kalmbach, Inc., of Denver, Colo. His work will be connected with the Indus River Development Program being sponsored by the World Bank.

Eugene A. Zwenig, an assistant professor of civil engineering at the University of Chattanooga, is recipient of a grant from the U.S. Public Health Service for advance study at the University of Pittsburgh. A Ph.D. candidate in public health engineering, Professor Zwenig hopes to develop a public health engineering curriculum for southern schools.

Frank Valenziano recently was promoted from group engineer in the engineering department of the Lock Joint Pipe Company at East Orange, N. J., to division engineer at the company's research center in Wharton, N. J. In addition to broad experience in product design and development Mr. Valenziano is co-inventor on a patent for the Tapping of Pressure Pipe, and is co-author of several patent applications.

Harold B. Gotaas, dean of Northwestern University's Technological Institute, has been appointed to the engineering sciences committee of the National Science Foundation for a three-year term. Dean Gotaas who is widely recognized for his research in the field of sanitary engineering and environmental control, recently completed a four-year term on the national health advisory council of the Public Health Service.

Walter P. Schmitz has resigned as engineer in charge of the Construction Division of the City of Milwaukee after 12 years as a city employee. He will join Rock Contractors, Inc., a Milwaukee firm engaged in public works in the metropolitan area.

Warren O. Carlson, in his capacity as the new vice president in charge of the Refining Division at Calgary, Alberta, of BEACO, Ltd., will be responsible for all the company's activities in the petroleum refining, petro-chemical, and gas processing fields. Before joining BEACO, Mr. Carlson was with the C. W. Nofsinger Company, a Kansas City, Mo., consulting firm.

Bernard S. Appleton has left his post as chief engineer and assistant general manager of the Greer Marine Corporation, a subsidiary of the General American Transportation Corporation, to become president and general manager of Disogrin Industries, Inc., of Mount Vernon, N. Y. His previous experience in the field of structural and hydraulic industries included association with Greer Hydraulics, Inc., and the American Bridge Division of the U. S. Steel Corporation.

Merlin D. Copen, George C. Rouse, and **George B. Wallace,** three Bureau of Reclamation engineers on the staff of the Assistant Commissioner and Chief Engineer Grant Bloodgood, returned recently from a two-month study of European dams, especially the current European trend towards thin-arch dams. Each man is a specialist—Mr. Copen, in the mathematical analyses of the various stresses in concrete dams; Mr. Rouse, in structural model studies and in instrumentation for mass concrete dams; and Mr. Wallace, in construction methods and materials.

M. D. Copen

G. C. Rouse

G. B. Wallace

(Continued on page 28)

CONSTRUCT
or OBSTRUCT

Do the taxpayers of your city call your utility work "Progress" or "Pestilence"? If your sewerage work is synonomous with road blocks and traffic jams — if it's costly and creates hazards — chances are the thanks you get will be mingled with justifiable protests.

To be noticed for improvements and not for nuisances, specify "BORING" by BorTunCo.

Now the BorTunCo Group* brings fast service to any contractor within a 400 mile radius of any division office.

When you specify "BORING" by BorTunCo, you eliminate dangers of open cuts in traffic areas, avoid traffic jams and detours, remove the necessity for unsightly patches in the streets. Furthermore, boring often results in substantial savings in total costs.

When you specify "BORING" by BorTunCo, you will insure the gratitude — not the protests — of the taxpayers.

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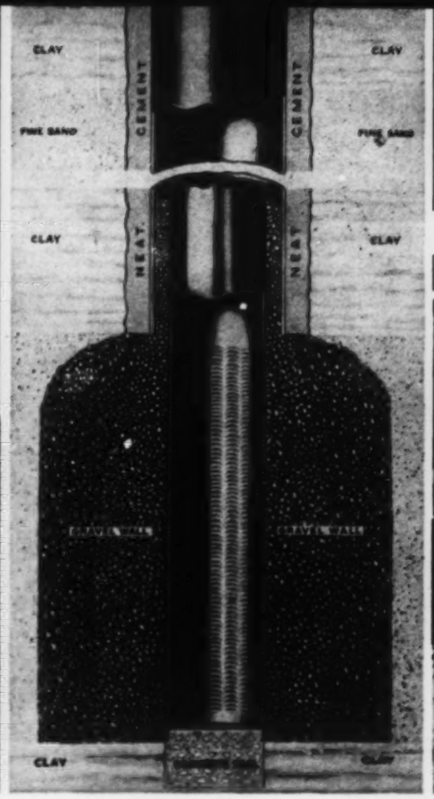
*Negotiations and inquiries strictly confidential



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With A Layne Drilled Well Layne knows where the water-bearing formations are located. They have been drilling wells for over 75 years. This experience comes from searching and researching water aquifers. Knowing *where* to drill is half of the success—knowing *how* is the other half. In drilling a straight well experience counts—and you can count on Layne. Layne specializes in water well drilling. To get a good start for a water supply—you need a good well. You get a good, producing well when you specify a Layne drilled well. *Bulletin No. 100*

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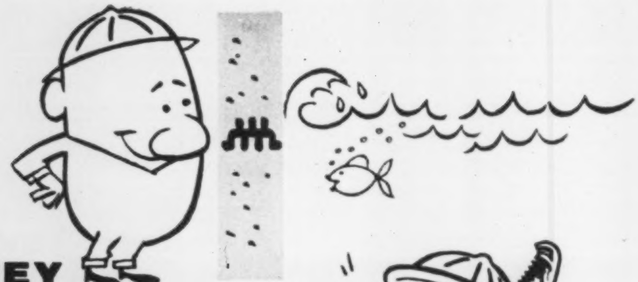

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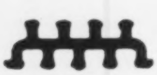

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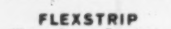

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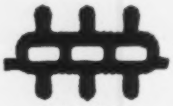

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Charles Edward Jacob, a consulting engineer specializing in underground water supply and drainage work, with offices in Northridge, Calif., has been appointed lecturer at the California Institute of Technology. Formerly head of the department of geophysics at the University of Utah and professor of geology at Brigham Young University, Mr. Jacob has maintained a fulltime consulting practice since 1954.

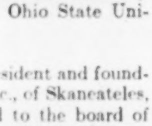
Arthur C. Nauman, until recently deputy engineer with the Eighth U.S. Army in Korea, has a new assignment as Mediterranean division engineer, Corps of Engineers, with headquarters at Leghorn, Italy. Prior to his Korean assignment in 1959, Colonel Nauman served for three years in Washington, D. C., as an assistant chief of civil works in the Office of the Chief of Engineers. A previous one-year assignment was with the Military Liaison Committee to the Atomic Energy Commission in the Office of the Secretary of Defense.

Don W. Handley has left the Turner Construction Company, in Philadelphia, where he was project engineer and construction superintendent to become project engineer with George K. Heebner, Inc., also of Philadelphia. Mr. Handley is a recent graduate of Ohio State University.

Arve S. Wikstrom, president and founder of A. S. Wikstrom, Inc., of Skaneateles, N. Y., has been elected to the board of directors of the Marine Midland Trust Company of Central New York. Since forming his own firm in 1935, Mr. Wikstrom has been active in the heavy construction business.

James Hamilton Schaub, an authority on soil mechanics, transportation engineering, and engineering materials, has been appointed chairman of the department of civil engineering at West Virginia University. Dr. Schaub goes to West Virginia from Purdue University, where he has been on the faculty for the past two years while completing studies toward the doctoral degree.

Linvil G. Rich, professor of civil engineering at the Illinois Institute of Technology, will become head of the Clemson College civil engineering department on February 1. As assistant professor of sanitary engineering at the Virginia Polytechnic Institute from 1949 to 1951 and head of the sanitary engineering division there from 1951 to 1955, Dr. Rich revised VPI's sanitary engineering curricula and organized a program of study leading to the doctorate.



(Continued on page 107)

. . . . . Am-Soc Briefs

▶ ▶ In step with the times. . . . Research was a recurring theme at the Boston Convention, with almost every speaker mentioning either the need for more of it in his field or its importance in the present-day picture. . . . To strengthen and expand the Society's program in this vital area, the Board of Direction authorized matching funds for a $10,000 grant from the Engineering Foundation.

▶ ▶ The obligation of the civil engineering profession in many areas of modern life — from urban renewal to world development and understanding — was stressed in a series of luncheon talks. In a major talk Dr. James R. Killian, chairman of the M.I.T. Corporation, said that the U.S. should have the courage to pursue its own objectives without engaging in a prestige race with the Soviets, and called upon the profession to participate in the responsibility of shaping "sound public policy." Excerpts from Dr. Killian's significant talk are reported on page 65.

▶ ▶ During the traditional Convention honors program a new ASCE award honoring Harvard University's Dr. Karl Terzaghi as the grand old man of soil mechanics was set up. . . . Another new ASCE prize -- the Theodore von Karman Award, given for distinguished achievement in engineering mechanics — was presented for the first time at Boston. . . . Unusual, and pleasant, was the "friendship award" given new ASCE President Glenn Holcomb by appreciative former students.

▶ ▶ A job well done. . . . Contributing to the good cheer at the Wednesday morning general meeting was the formal announcement of the successful windup in August of the Society's drive for funds for the United Engineering Center.

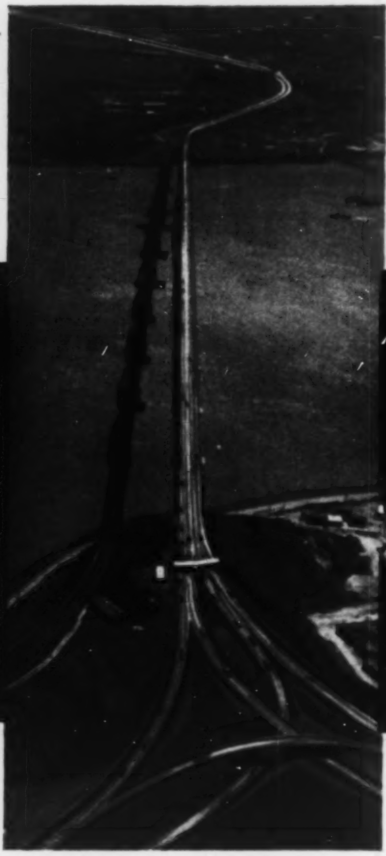
▶ ▶ What's new in the UEC campaign. . . . Forty-nine Sections have met their quotas in the campaign for funds and now have Honor Roll status. Additions to the list since the drive went over the top are Seattle, Tacoma, Intermountain, and Pittsburgh. With $816,555 to its credit (as of October 21), ASCE's campaign has reached the 102 percent mark. Happily, 82 percent of ASCE pledges have been paid in full. . . . A contract has been signed for sale of the Engineering Societies Building, and an initial payment made.

▶ ▶ Over on United Nations Plaza, in the meantime, work on the UEC is on schedule. The limestone facade for the southeast corner has been carried to the top, and window frames are more than half completed. It's good news, too, that several strikes which threatened to delay the work have been settled.

PROGRESS REPORT

BENICIA-MARTINEZ BRIDGE

HOW TO BUILD A BRIDGE



Drawing of high level Benicia-Martinez Bridge across upper San Francisco Bay. Scheduled for completion in 1962, bridge will be 6215 feet long, a maximum of 187 feet high, 62 feet wide between curbs.

First of nine concrete box piers is floated to pier site. Each weighs 1700 tons, is 44 feet wide, 86 feet long, about 25 feet deep. Caissons are installed through footing into a minimum of seven feet of bedrock.

New idea: floating concrete footings in bridge pier construction — fabricated and erected by Yuba

Engineers and contractors are taking a close look at the time and cost saving ideas being put to work by Yuba in the construction of this mile long bridge. Especially to the new method of box footings for the nine water piers, designed by the California Division of Highways and developed by Yuba engineers.

Briefly, box footings of reinforced concrete are prefabricated with three rows of six cells, 13 feet square. These, with circular spaces provided for caissons, give buoyancy for floating the footings to the sites. After 80" diameter casings are extended down to firm material, holes are drilled to a depth of at least 7 feet into bedrock. Caissons are seated into bedrock drillings, reinforcing cages are set, tremie concrete is poured. These legs are used to support box footings, upon which slipforms are then used to complete the piers to final elevation.

On this and other major projects, Yuba has introduced new techniques and specialized land and water equipment and procedures that solve major problems, save time and money. If your heavy structural or mechanical project calls for this type of experience, imagination and technical proficiency, call on Yuba. Operations nationwide.

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do you know that

U.S. motorists have chalked up over ten trillion miles since the turn of the century? In 1900, the year of the first automobile show, only 4,192 Americans were venturesome enough to buy the "horseless carriages." Of these cars 1,575 were electrics, 1,678 were steam powered, and 939 were "hydrocarbon" machines—the name then given to gasoline-powered cars. In the whole country there were fewer than 8,000 cars, many of them European imports. In 1960—the year of the 43rd Automobile Show—over 5 million American cars, all "hydrocarbon" machines, will be bought and added to the 57 million already on our highways. Our thanks for this to Ralph Stein, automobile editor of *This Week*.

■ ■ ■

Motor-vehicle registrations are expected to reach 73,868,000 for 1960? According to the U.S. Bureau of Public Roads, there will probably be a gain of 3.3 percent over 1959 registrations. Passenger cars are expected to account for 61,569,000 of the 1960 registrations, and trucks and buses for the rest. California will again lead with 7.8 million, followed by New York with 5.1 million. Texas, Pennsylvania, and Ohio will each have over 4 million.

■ ■ ■

A huge new Columbia Basin Project seems likely? With the President giving his support to a plan for joint U.S.-Canadian development of additional Columbia Basin water resources, the way seems clear for a multi-billion-dollar Pacific Northwest Project. The proposed Canadian reservoir system, providing 15,000,000 acre-ft of storage for flood control and hydroelectric power, would give the U.S. initial benefits of 1,686,000 kw of low-cost power, the equivalent of another Grand Coulee Dam.

■ ■ ■

Over 80.3 million tons of steel were made in the first nine months of 1960? Despite the spring and summer slump in output, the nine-month total was the fifth highest for any similar period on record. It exceeds the 72,484,673 tons made in the first nine months of 1959, when production was held down by the steel strike. Steelmaking facilities during the present nine-month period were utilized at an average of 72.1 percent of capacity.

■ ■ ■

New York International Airport is the nation's fourth largest port of entry? Even without its ocean commerce, New York is still one of our top-ranking ports because of the huge volume of overseas air freight handled at International Airport. In 1959 duties collected on airborne imports amounted to nearly $54 million—more than customs collections at all other U.S. ports except Los Angeles and New Orleans.

Competition for highway work continues keen? The result—reported by the U.S. Bureau of Public Roads—is that prices are well under state highway department estimates. An analysis of 1,706 contracts awarded during the first six months of the year for Interstate and other Primary System projects shows that the low bidders were 11.1 percent under the state engineers' estimates. In 29 states savings ran even higher.

■ ■ ■

Three methods of removing radioactive contaminants from drinking water have been developed by the Corps of Engineers? The Sanitary Engineering Branch of the Research and Development Laboratories at Fort Belvoir reports favorable results using a standard purification unit, consisting of chemical coagulation and diatomite filtration, called an "Erdlator"; a mobile ion-exchange unit; and an electrodialysis demineralization process. Tests were conducted at the Nevada Test Site in the area where atomic bombs were once tested.

■ ■ ■

Census figures show a pattern disturbing to city planners and administrators? Most major cities actually lost population in the past ten years, although metropolitan areas, including suburbs, generally remained stable or gained. The exceptions are Los Angeles, Houston, Dallas, Milwaukee, Seattle, and Atlanta.

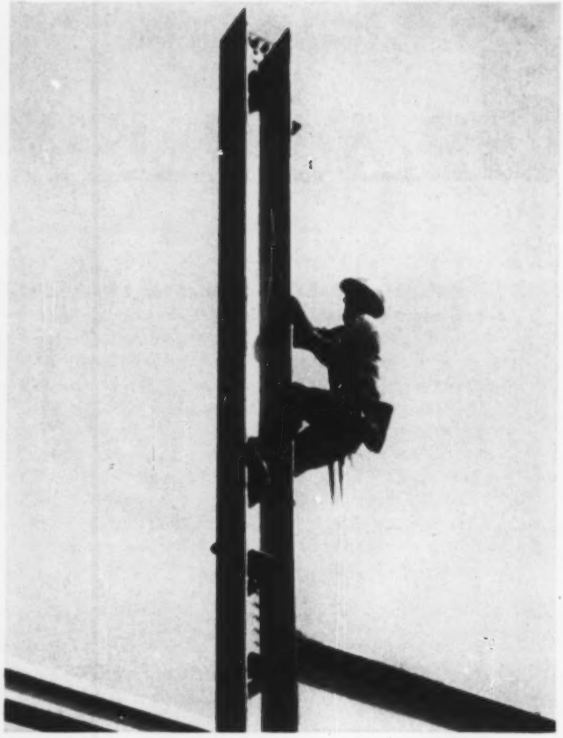
■ ■ ■

After half a century polluted water has again become a public health hazard? According to the U.S. Public Health Service, the construction of 4,000 new sewage treatment plants and the modernization of 1,700 more are urgently needed to handle the present load of municipal sewage dumped into the nation's rivers and streams. The cost is put at $4.6 billion. The pressing pollution problem will be studied at a National Water Pollution Conference, called by the President for December 12-14. Headquarters will be the Sheraton-Park Hotel, Washington.

■ ■ ■

The world has adopted a new standard of length? The new international standard—a wave length of light—replaces the meter bar which has served as the standard for over seventy years. The action—taken by the Eleventh General Conference on Weights and Measures, held in Paris this October—is of great concern to scientists and others engaged in precision measurements if not to the man in the street. In an article in the current issue, Floyd W. Hough advocates that the U.S. adopt the metric system of weights and measures now but allow a full generation to put it into full effect.

Build faster and speed your payoff ...with STEEL



Steel buildings really go up in a hurry these days—three stories per week in a typical apartment house.

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TIME FOR ACTION

GLENN W. HOLCOMB, PRESIDENT, ASCE

Professor and Chairman
Department of Civil Engineering
Oregon State College, Corvallis, Oreg.

The engineering profession today is challenged by the accelerated rate of progress brought about by the character of the times in which we are living. Conditions outside the profession have created the need for greatly accelerated activity in research and development to keep pace with the very rapid progress in scientific knowledge. This challenge must be met both professionally and technically to warrant the prestige we want to uphold in the civil engineering profession.

It is often stated that the work of our Society must be coordinated with that of other professional societies, with industry, government agencies and others. If this is true, and I believe it is, then to accomplish this we must have the support and aid of all our members. The effort of a few will not suffice. It is the combined effort, the group energy, that will bring about the desired results. We will not maintain our prestige by an attitude of indifference toward our professional and educational objectives.

Progress requires effort

You have only to look around you in your own states to observe advancement in the projects of the civil engineer of which he can be proud. Progress will be noted if a comparison is made with similar work of twenty to forty years ago. Also, a comparison with the work of engineers in other fields of human need will show that ours has a more permanent aspect. Perhaps we are fortunate that in civil engineering practice the changes are gradual so that we have an opportunity to adjust to them.

We engineers can point with justifiable pride to the many fine projects that are conceived, designed and constructed with great skill and care each year in the United States and in the world. Yet the ugly word "failure" has been creeping ominously into our field in recent years. It is a recognized human reaction, of course, to pay more attention to mistakes, or to something that has gone wrong, than to successful endeavors. Even so, we must be alert to the possibilities for error. Here our Society can lend a hand. It is the function of ASCE to continuously provide facilities for the improvement of engineering techniques through its research, specialty conferences, and publications.

Each Local Section of ASCE should be alert and ready to correct wrong impressions of the profession such as that expressed in an article in the July issue of the *Readers Digest*. It is regrettable that this magazine, with its good reputation, should draw such conclusions on the evidence it is reputed to have gathered. Each Local Section, I am sure, will take such steps as are necessary to defend our Interstate Highway System, as well as the professional engineers and the many other loyal employees of the state highway departments and the Bureau of Public Roads who are employed in this work where they are deserving of defense. Neither the Society nor its members can condone dishonest or careless work by or for engineers.

ASCE desires its committees to be active and, I would add, aggressive. Careful consideration and thought go into the establishment of a committee and the development of its assignment. A few are in the nature of standby committees, ready to take action on conditions that may suddenly arise; the majority are expected to be continuously active and to prepare reports at specified times. A committee with no report is a committee that is not doing its assigned task. At least a report should be presented explaining why there has been no activity. We who accept positions on the committees should be prepared to give the time necessary to make these committees valuable to the profession. We owe this to our fellow engineers when we accept such appointments.

Problems in education

One of the urgent problems of the civil engineering profession is that in many of the engineering schools the quantity and quality of the students who elect civil engineering has been diminishing in the past two years. It is reported that some schools with very high entrance requirements and limitations on the number of admissions are having difficulty in filling their classes even though they offer free tuition.

In 1955, ASEE issued a Report on the Evaluation of Engineering Education (Grinter Report), which has influenced the revision of many curricula since that date. However, many civil engineering educators believe that the report did not consider the needs of the civil engineering profession.

In 1957, an ASCE Task Committee on Professional Education presented a report favoring a five-year course and stressed the need to improve the quality of curricula. In July of this year, ASCE was cosponsor of a Conference on Civil Engineering Education at Ann Arbor, Mich. The National Science Foundation underwrote the cost of the conference to delegates. The conference delegates, representing about 138 educational institutions, together with 130 other interested engineering educators and practicing engineers, discussed civil engineering education for two and one-half days.

This conference in Ann Arbor was marred by some confusion, lack of togetherness and misunderstanding. It accomplished one thing, however; it indicated that there was no agreement on a program of engineering education. The ASCE Education Committee has worked hard on this problem for seven years that I know of. Now I can assure the committee members that they will have the interest and attention of the membership if they have not had it in the past.

The present recognized work of the civil engineer—such as the design and construction of bridges, buildings, dams, water and waste disposal plants, airfields and many other structures—requires a broader knowledge than can be obtained from training in science alone. Such projects are each made up of many parts which must be assembled into a working unit. Each is custom made, and requires a training in all the subjects covered in the work of all the different technicians who may be needed on the project as a whole. We should not, I believe, leave gaps in the training of our young engineers.

The engineers of this country have done a reasonably good job following the methods of the past. So I say let's encourage the faculties of our schools to continue to develop their institutions as individual units, and to perfect their educational programs to turn out the best engineer possible. We must urge the gifted student to look toward graduate work. We must urge experimentation, research, and a free exchange of information. To me this seems to be the process by which progress will continue. Progress will not come through standardization.

To assist the educational institutions and make certain that the end product of undergraduate study, namely the graduate, has received competent professional training, the Engineers' Council for Professional Development was formed. ECPD has been defined as "a federation of engineering societies which does the specific job of sponsoring the individual development of the individual engineer."

ECPD, through the many engineers working on its accrediting teams, carries a heavy work load in its accrediting program. We owe these men a debt of gratitude for the contributions they are making to the engineering profession through ECPD.

Professional conduct

Another aspect of the profession that has presented an increasingly troublesome problem in the past few years is that broad area known as professional conduct and practice. This of course involves our Code of Ethics. I believe the committee of the Society associated with this area has the most confusing and perplexing duties of any of our committees. It appears that the only way to solve these problems is to increase the awareness of the individual member of the fact that high professional standards and ethics are really a part of the profession. Progress in this direction has been heartening. What we now need is a clear, descriptive manual of professional practice and a board of impartial judges to administer whatever policy is deemed to be in the best interest of the profession.

A Professional Recognition Award has been instituted by the Society from funds contributed by Edmund Friedman, F. ASCE. If we could in some way make all our members conscious of the objectives of this Award and desirous of meeting them, our professional battle would have been won. It is inconceivable to me that there could be problems of professional conduct or violations of the Code of Ethics among our members if each were striving to win the Professional Recognition Award.

Plan a program on EJC

Engineers Joint Council provides the vehicle for correlating and coordinating the work of the different societies of engineers. EJC is not another society. It takes nothing away from any society; it is really an assembly or union of societies. ASCE, through its representatives on the EJC Board and committees, participates both in its local and in its worldwide work of special interest to engineers. During the past year, EJC has started reporting directly to the membership through the newspaper *Engineer*.

We should make it our business as individual society members to study the objectives of EJC—what it stands for, how it functions, what it does. Once the membership thoroughly understands the activities of EJC, I believe that it will have a better understanding of all engineering societies and an appreciation of the value of EJC as a coordinating agency at the professional level. A review of the many committees and panels working for EJC will immediately give an appreciation of the important work that is being accomplished by EJC.

I hope each Local Section will present a program devoted to EJC in the coming year. Also Local Section publications can properly and profitably give substantial space to EJC activities.

Louis Howson, a Past President of ASCE, made a statement that to me sums up the need of all engineers to be heard through all possible means of communication: "When engineers fail to communicate to others the character of their professional work, they lose deserved recognition and lessen their opportunity to serve humanity." This quotation to me truly states the position of engineers and their relation to the general public.

Working at public relations

Are we engineers willing to take time to give community talks whether the subject is directly related to engineering or not? Do we do things in our respective communities to make people conscious of civil engineers and the importance of their work to the community? Do we explain the relationship of highways, buildings, water supplies, flood control projects and so on to community life? An informed public is a friendly public.

I urge each of you to aid in furthering good public relations, working as individuals and through your Local Section committees. Share ideas on this subject with others in your Local Section; be prompt in making your ideas known to Society Headquarters. Your suggestion may be just what is needed in some other Local Section.

In conclusion, let me urge each of you not to be satisfied with our profession as it is today, either technically or professionally. The engineering profession cannot be static in a world such as this. An active profession can only be built by an active membership. The slide rule gives way to the computer, pistons give way to jets, trails give way to freeways, and so the advance continues. The profession keeps abreast of the progress it creates only to the extent that its individual members are tireless in their search for knowledge and in improving the condition of their fellow men.

Atlantic-bound ship at left requires services of eight "mules;" Pacific-bound ship at right needs ten. When the new machines are in service, only four will be required by ship at left, six (the maximum) by ship at right.

New "mules" for the Panama Canal

ROBERT D. BROWN, JR., F. ASCE, Lt. Col., CE, USA;
Director, Engineering and Construction Bureau, Panama Canal Company, Canal Zone

More than half a century ago the designers of the Panama Canal made a fundamental decision that is still with us today. They decided that ocean-going ships would need mechanical assistance while passing through the Canal's massive lock chambers, and they provided a family of 45-ton, 25-cycle electric towing locomotives for the job.

The old gray mule

The need for these electric "mules" is greater today than it was the day the Canal opened. Sixty-seven of them are now in service, forty being machines originally delivered in 1914 by the General Electric Company. The remainder were constructed locally. Many of the 25-cycle traction motors have been rewound; others will soon need major overhaul. Replacement parts are no longer available but must be specially fabricated. Main gearing, brakes, cable coiling mechanisms, wiring, are all essentially unchanged. All are worn.

Then as now the "mules" were intended for pulling and braking ships as they pass from one chamber to the next, and for steadying them in the lock chambers during filling and emptying operations.

A "mule" is essentially a self-propelled winch, and those at Miraflores and Pedro Miguel Locks happen to be gray as well as old. For some unaccountable reason, the Gatun Lock mules are black. The specifications for these mules are of some importance in this article, because the new machines become significant only when it is known what the present mules are and can do.

The old locomotives contain two 220-v, 25-cycle, main traction motors. When towing or otherwise assisting ships, they make use of a rack drive. Each has an operating cab at each end, and centrally located is a friction-drive towing drum with jaw clutches. Speeds are limited to 1 and 2 mph by rack drive; and to 2½ and 5 mph by wheel drive. Only rack drive is used during ship handling.

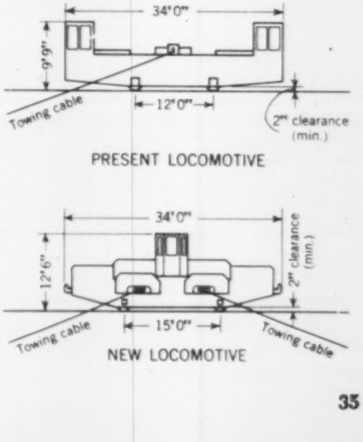
The towing drum contains 500 ft of 1-in. steel cable, and is adjusted to allow a maximum tension of 25,000 lb before slipping. In operation, this is not especially satisfactory as the friction drive requires excessive maintenance, and the multi-layer cable coiling operation results in too many back-lashes and too much cable kinking, with consequent cable breakage. The electric current is picked up by a plow from a conductor slot. Safety wheels, which ride the bottom of the driving rack, make overturning virtually impossible.

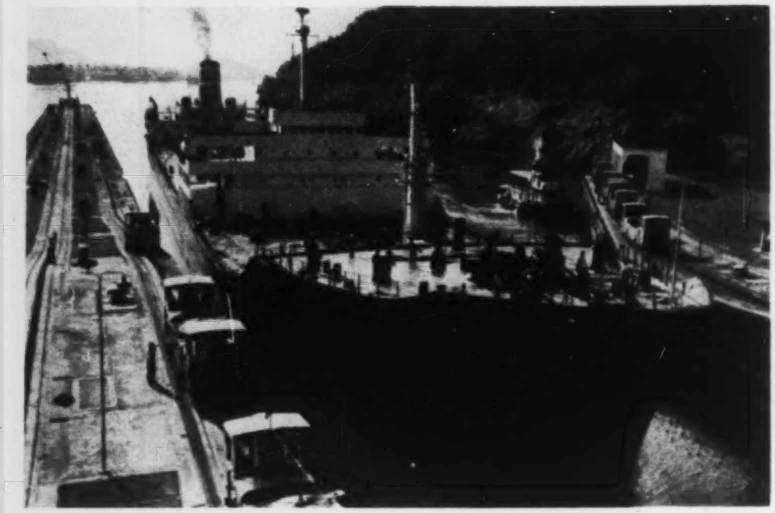
Need for mechanical assistance

When all other major canals and waterways in the world get along without towing machines, it is fair to ask why the Panama Canal needs such equipment. The explanation lies both in the physical characteristics of the Canal and in the peculiarities of its ocean-going customers.

On "up" lockages a ship is subject to currents or unusual hydraulic forces of one sort or another from the moment it approaches the lower lock chamber. The first currents encountered are due to the spilling of fresh water from this chamber into the restricted lock approach channel. This water movement simply brings the water level in the lower chamber down

FIG. 1. New "mules" for the Panama Canal will each have two towing cables and more than twice the power of units now in use. Length of present unit should be 33 ft. See Table I.





The "Penn Challenger," Atlantic bound, enters Miraflores Locks. Although it requires ten of the old mules, it will need only four to six of the new type.

TABLE I. Old and new locomotives compared

Item	Old	New
Length	33 ft	34 ft
Width	8 ft 4 in.	9 ft 8 in.
Height	9 ft 9 in.	12 ft 6 in.
Weight	90,000 lb	90,000 lb
Traction motors	Wound rotor	Wound rotor
Number	2	2
Power	75 hp each	170 hp each
Voltage	220 v	440 v
Frequency	25 cps	60 cps
Towing speeds	1 or 2 mph	1, 2, or 3 mph
Return speeds	5 mph	6 or 9 mph
Drive type	Gear train with pinion and rack	Gear train with pinion and rack
Winches	1	2
Stalled pull	25,000 lb	35,000 lb each
Low speed and pull	25,000 lb @ 12½ fpm	20,000 lb @ 20 fpm each
High speed and pull	nil @ 188 fpm	2,500 lb @ 190 fpm each
Maximum towing force	25,000 lb	70,000 lb
Frame	Cast iron	Welded steel
Body	Painted sheet steel	Stainless steel

to sea level in preparation for the acceptance of the next "up" ship. The mixing of fresh and salt water causes strong local currents, which however subside within a very short time.

Immediately thereafter, the lower gates are opened to receive the ship. This causes an almost violent mixing of a large block of fresh water with contiguous ocean water. The resulting currents are more pronounced than before, and last longer, as the fresh lock water moves out at the top and the heavier sea water comes in at the bottom.

After the ship has entered the lower chamber, and after the lower miter gates have been closed, the filling operation begins. Water is admitted by gravity flow from the next higher chamber, entering through ports in the lock floor. The entrance of this large volume of water tends to move the ship both longitudinally and laterally. Except for the steadying effect of the mules, the ship would be slowly forced against the center wall.

Ship characteristics also require that mechanical aids be available. The very fact that the vessels are ocean-going, with thin steel plating, dissimilar in every way from the tough and rugged construction of lake ore carriers, makes it essential that they be handled positively through the locks. They must not be allowed to strike or scrape the rough concrete walls.

The Sault Ste. Marie and Welland Canals are similar in many physical ways to the Panama Canal but their customers are different. The ore ships that comprise most of their traffic have a marked "tumble-home," and at the outermost point, near and just above the fully loaded water line, they have a steel rubbing strake for easy sliding along the concrete. Ocean-going ships, on the other hand, have a pronounced flair, especially up forward. The widest part of the hull is normally well above the water line. A rubbing strake would be geometrically out of the question even if the hulls could stand it structurally.

The principle of mechanical assistance is therefore well justified. The problem is to retire the old machines and build new ones to suit the more demanding pace, and larger ships, of today.

Early studies and experiments

The Chief of the Panama Canal Company's Locks Division, Roy Stockham, first called for a mule replacement program in 1949. Largely at his urging, economic and engineering studies were undertaken in an effort to decide between major rehabilitation of existing mules or their complete replacement.

In 1957, the Panama Canal Company signed a contract for the production and delivery of two radically different towing devices. The main features of these machines were the use of two cables from each mule instead of one, for ship handling, and the use of a vertical "fender" mechanism that would make it possible to handle ships from the center wall only. The "fender" was an assembly of large rubber tires, raised and lowered by a 45-ft vertical mast rack. It formed part of each mule, and was moved along the lock wall in such a way as to provide a protective buffer between the wall and the ship.

Although these two experimental devices were a sign of progress, they would have required years of development and many improvements, with no guarantee of final acceptability. Therefore, after several months of trials in operational situations, the Board of Directors called off further testing and directed Panama Canal engineers to prepare final performance specifications for mules similar to the old.

The stainless-steel mule, circa 1961

After the novel had been tried and the more conventional chosen, the idea was to pack as many reasonable improvements into the new equipment as possible. Table I and Fig. 1 give a general comparison between the old and the new machines.

Each of the principal changes was included for a good, specific reason. A top speed of 9 mph, for example, cuts about 4½ minutes from the lockage interval at Gatun Locks. With today's problem of canal capacity, this feature is more important than it looks, especially when one lane is out of service and all traffic must pass through the other.

The idea of two winches per machine was suggested in 1955 by Carl Giroux, formerly Special Assistant to the Chief of Engineers, and now an independent consulting engineer. This idea, which proved workable on the experimental devices, was adopted for the new machines. It reduces the total number of machines per ship and per lock. Also, greater force per cable, and more tractive effort, are available. Each machine is capable of more than double the effect of existing mules. Here there is a practical limit to how much towing or braking force can be applied, and in the new machines the practical limit is approached. The maximum capacity of the closed chocks and bits on shipboard is on the order of 50,000 lb. Also, there are practical limitations on the ability of the existing lock-track system to resist towing forces.

The most unusual improvement of all is the level-wind, single-wrap towing winch. Because of the operational difficulties experienced over the years with the old drums—such as cable snarling, kinking and breaking—the new level-wind drum with its positive payout, anti-backlash device is a most welcome innovation.

The winch is really the heart of the new mule. Two winch speeds are provided for paying out or coiling in—20 fpm and 190 fpm. The cable is able to pull 35,000 lb in the stalled condition and 20,000 lb at 20 fpm. It must also pull 2,500 lb at the maximum speed setting. The cable will withstand slipping at 35,000 lb while leaving the drum at 150 fpm.

Effect on canal operations

Obviously the new machines are expected to solve today's serious maintenance problem. Lock operations will undergo a change. Two cables, rather than one, will be put aboard ship for each machine, but there will be fewer machines. Ships that required four of the old mules (two on each side) will require only two of the new. Those requiring ten or twelve of the old, as is the case for the very largest tankers, will be easily handled by six, or at the most eight, of the new. Lockages in general will move just a little faster, especially at Gatun and Miraflores, and this will directly increase the capacity of the Canal.

Just a year from now, on October 12, 1961, the first six machines are expected to be ready for final on-site trials at Miraflores Locks. Shortly before this, the last 25-cycle lockage at that set of locks, using the old mules, will have been completed. The locks will be changed to 60-cycle operation immediately afterwards.

The main traction motors are required to pass speed-torque tests. The winch assembly, the heart of the machine, will undergo 5,000 full cycles of operation, at least 2,000 of these at the maximum pull speed of 20 fpm. The machine will ascend and descend a replica of the steep (50 percent of grade) incline at Miraflores some 4,000 times. This is equivalent to one full year of operation.

Every precaution will be taken to see that the new towing units are what they should be, mechanically, metallurgically, electrically and structurally before they arrive at Panama.

Sales engineering is professional

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Undoubtedly the profession of sales engineering is the field most unrelated to other branches of engineering. Perhaps a closer look at the sales engineer and his activities will provide a more complete understanding of this ever-growing field.

What is a sales engineer? Many know him as a salesman, a sales representative or "peddler"—an appellation he dislikes intensely. Actually, he is often better qualified as an engineer than he is as a salesman. Or put it another way —he is a technically trained engineer, a well-paid product consultant who is also a qualified public speaker and functions as his own manager in the day-to-day practice of selling.

Formal training received from an accredited engineering college is only the beginning for sales work. Additional study, varying from six months to two years, is normally required by industrial companies before an engineer is given the full responsibility of a sales assignment. This training provides a thorough understanding of the development, design, manufacture, marketing, and use of the company's products.

During the program, special emphasis is placed on historical information concerning the product. Numerous inspections of materials under actual service conditions are made. Installation practices are watched to gain on-the-job experience under the direction of skilled crews. Special problems are studied in structural analysis and design. Of course, complete indoctrination in company policies is included. Needless to say, the sales engineer is expected to be an expert trouble-shooter, design consultant, construction advisor, industrial engineer, job estimator, and a student of human nature. He carries around with him at all times complete and detailed information on all the products of the company he represents.

Industry frequently has been severely, and in my opinion unjustly, criticized for contributing to the shortage of engineers, supposedly wasting engineering talent by requiring engineering graduates for sales assignments. Engineering training is invaluable when you consider that an average of 60 to 70 percent of the sales engineer's time is spent consulting or working with design engineers in federal and state agencies, private practice and industry. He must know and be able to explain the application and the limitations of products that might be considered in a good, sound engineering design. And he must know his competitors' products as well.

It would be almost impossible for the designer or the construction contractor to personally concern himself, or his staff, with the details about all the engineered products available for a particular project. Designers, construction engineers, and buyers welcome reliable product information and engineering assistance provided by competent sales engineers. There is no place in the engineering profession for the glad-handing, back-slapping, flashily dressed salesman who puts in an infrequent appearance from a faraway city and offers a hot price on a product without a name.

The sales engineer is a serious-minded, respected member of the community and frequently he is a licensed engineer. He is interested in promoting the betterment of the engineering profession through active participation in local and national engineering societies.

Opportunities for the sales engineer are somewhat parallel to those for the self-employed person. Advancement depends on individual talent and hard work. It is not uncommon for experienced sales engineers to earn $10,000 a year, supplemented by attractive fringe benefits. For those who are not content to be career sales engineers, there are many opportunities for advancement on the management staff. Many large firms rely heavily on their sales engineering personnel as their main source of management people.

The hours are long and the schedule is irregular. The job—to make money for the company and to offer economy for the customer—is a challenge that is ever present and always a measure of the sales engineer's success. A successful engineer—a professional engineer? Definitely. A salesman? Without a doubt! And what successful engineer isn't?

Pumping saves water and power in fish-passage facilities

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Pumped water to attract fish to upstream passageways is saving valuable energy water at Pacific Northwest dams. The pumping equipment at these facilities is both tremendous in size and unique in design. At Ice Harbor Dam for example, 3,150 cfs of pumping capacity is installed, and 7,500 cfs at McNary Dam; each would make quite a substantial river. It is far more economical to pump the quantities of low-head attraction water from the tailwater pool than to divert high-head water from the power turbines.

The Columbia River and its tributaries constitute by far the largest hydro-power stream system in the United States, with a potential power capacity of 34,000,000 kw. The 1985 estimate of power consumption for this area is 23,000,000 kw, of which about 95 percent will be hydroelectric. The comprehensive development of the Columbia River and its tributaries—notably the Snake River—by private utilities, the U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation will require the construction of a considerable number of dams.

One of the most mysterious phenomena of nature is the periodic migration of anadromous fish. Species such as the salmon must be able to reach the spawning ground where they were hatched, and their fingerling offspring must be able to make the return downstream trip with a minimum of difficulty. Whenever a barrier to free passage of fish is placed across a watercourse, this natural process is prevented.

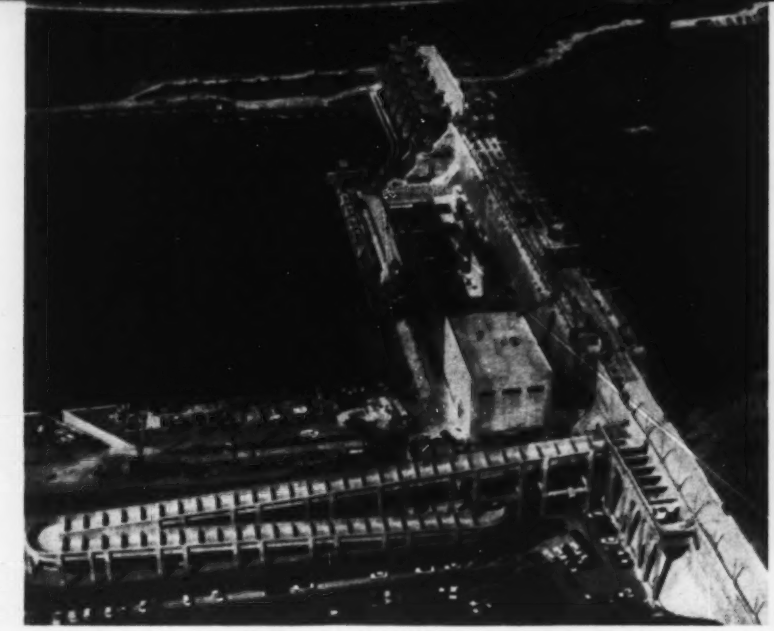
The harvest of salmon and steelhead from the Columbia River has been estimated at $20,000,000 annually. There is also recreation for the sports fisherman, the value of which cannot be estimated. The cost of including fish facilities averages a staggering $10,000,000 per dam, but the results more than justify the expenditure. A survey showed that, in one 16-hour period, 21,000 Chinook salmon passed through the fish facilities at McNary Dam. Chinook, the most numerous migrating fish on the Columbia, account for about 39 percent of the total number of fish that utilize the facilities. Considerable research is being done on artificial spawning areas, with promising results. To date however, successful spawning requires that the natural migratory process be followed. While passing upstream, the fish must not be injured, overexerted or unduly delayed.

It is evident that the fish cannot fight their way upstream through the tailwater of power turbines or through the spill water of a high dam. How then can they pass this barrier? There are several methods of transporting fish from the tailwater pool, past the dam, to the backwater. One way is to transport them in hoppers on mechanical tramways. Another is to install a fish lock similar to a navigation lock. The most widely used method is the fish ladder. No matter what transportation system is used, a successful method for attracting the fish is necessary. The sports fisherman with his lure is not alone in his efforts to attract fish.

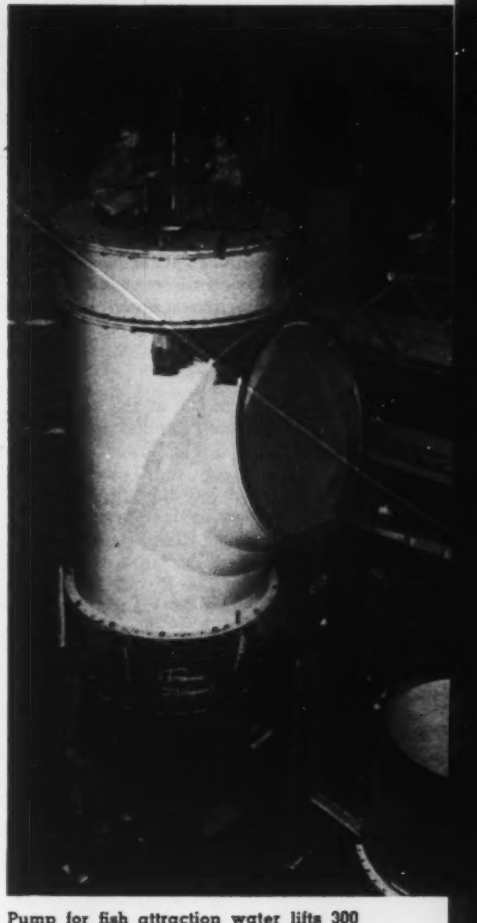
A fish ladder consists of a water-filled passage or a series of connected pools through which the fish swim up past the dam. Each pool has a 1-ft gain in elevation over the preceding one and is separated from it by a weir with a submerged orifice. The fish swim through this orifice to the next higher pool. Water flows from the backwater storage down the ladder to the tailwater pool below the dam. See Fig. 1. There are usually two fish ladders in each installation, one on each shore of the river. Within the fish passage, such conditions as flow, velocity and direction, water noises, and lighting must all duplicate those familiar to the fish. On the downstream trip the fingerlings usually pass through the power turbine, over the spillway, or through the trash flume. Under some conditions, however, special facilities for the downstream passage are also required.

Attraction water

Since research has shown that fish follow the shoreline, fish entrances at the center of the dam are not necessary. It has also been found that an entrance 6 ft below the surface of the tailwater pool attracts fish more efficiently than one that is deeper or closer to the surface. The most critical condition to be maintained at the fish entrances has been found to be a velocity against which the fish will naturally swim. Experiment has shown that each entrance must emit about 60 cfs of attraction water at a velocity between 4 and 8 fps. The velocity in the transportation channel must be main-



The fishway is a necessary bit of difficult construction at dams in the Northwest. Pumped water attracts salom to this fishway (in foreground) at Ice Harbor Dam.



Pump for fish attraction water lifts 300 cfs (193 mgd) against a 5-ft head.

tained at 2 fps. Provisions are usually made to adjust the flow so that the best results can be otained through field investigation under various hydraulic conditions.

Water flowing down a fish ladder from behind a dam is of insufficient quantity to produce the required flow conditions at the entrances and in the transportation channel. To allow additional water to flow from behind the dam for this purpose is not economical considering the amount of generated power that would be lost.

Pumps are therefore used to create attraction-water flow. These pumps take their suction directly from the tailwater pool and discharge into the collection channel. See Fig. 1. The attraction water flows through the collection channel, out through the fish entrances, and back into tailwater. The pumps never actually pump the fish; they swim against the attraction flow, through the entrances into the collection channel and then on to the fish ladder. They then swim from pool to pool of the ladder, gaining one foot of elevation at each pool, until they have reached the elevation of the backwater, where they are free to continue their upstream migration.

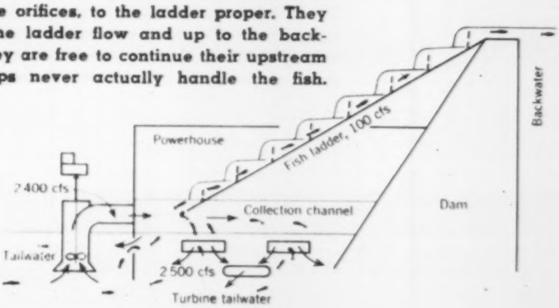
Total quantities of attraction water vary between installations. McNary Dam, for instance, requires a maximum capacity of 7,500 cfs through three pumps installed on the powerhouse side of the dam. The Ice Harbor installation will have a total capacity of 2,400 cfs installed on the powerhouse side of the dam and 750 cfs on the North Shore. These tremendous quantities of water at pool-to-pool heads ranging below 10 ft present a considerable pumping problem. Vertical wet-pit propeller pumps have proved best suited to meet these hydraulic requirements. In addition their physical configuration makes them well adapted to the limited space available in the pump structure. See Fig. 2.

In line with the impressive size of the generating equipment in the powerhouse, fish attraction facilities are among the largest continuous-duty pumping installations. The pumps at McNary, for instance, have impellers 20 ft in diameter and are driven by 2,800-hp motors.

Ice Harbor Lock and Dam

The Ice Harbor Lock and Dam project of the U.S. Army Corps of Engineers, scheduled for completion in 1961, is the first of four authorized dams on the lower Snake River that will extend slack-water navigation

FIG. 1. Schematic diagram shows Ice Harbor fish facilities. The fish swim against the pumped attraction-water flow into the entrance orifices, to the ladder proper. They then swim against the ladder flow and up to the backwater pool, where they are free to continue their upstream migration. The pumps never actually handle the fish.



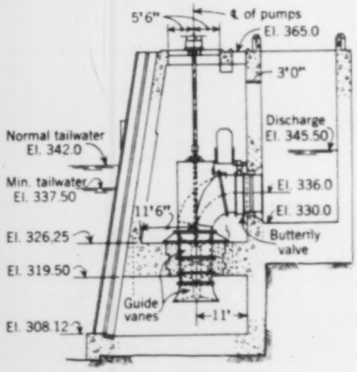


FIG. 2. At pump installation for fish attraction at Ice Harbor, suction pit opens directly into tailwater pool. The pump can be pulled out of the embedded case. This design allows complete maintenance from above rather than from below through the suction pit.

from the confluence of the Snake and Columbia Rivers 140 miles upstream to Lewiston, Idaho. The Lower Monumental, Little Goose and Lower Granite dams will complete this project, allowing slack-water navigation up the Columbia and Snake Rivers some 465 miles from tidewater. An annual traffic of 2,500,000 tons is expected to pass through the lock at Ice Harbor. The ultimate hydroelectric generating capacity will be 540,000 kw through six turbine generators.

The Ice Harbor Dam will have two separate fish ladders, one on each shore. Because of the attraction exerted by the turbine tailwater, the south shore or powerhouse side of the dam will have the larger fish facilities. These consist of entrances from the tailwater pool, transportation channels, the ladder proper, and the pump station. Of course, these basic components include an unbelievable number of control devices, supply conduits, and diffusion chambers as well as a fish counting station.

The south shore at Ice Harbor will have three entrance locations. The first is in the non-overflow part of the dam between the spillway and the powerhouse. The second, running across the base of the powerhouse, consists of twelve submerged orifices, each 8 ft by 1½ ft, two for each turbine tailrace. The third is made up of two 12-ft overflow weirs placed at the south end of the tailrace.

All three of these entrances come together at the collection and junction pool. Here, pumped attraction and transportation water is introduced to support the required flow conditions through the collection channel and out the fish entrances. The junction pool leads directly into the lower end of the fish ladder. To maintain proper attraction conditions at the entrances under maximum tailwater levels, the following amounts of attraction water are required:

Non-overflow entrance	1,000 cfs
12 powerhouse entrances	720
South entrance	780
Total	2,500 cfs

The fish-ladder flow from behind the dam is only 100 cfs; therefore a maximum pumping capacity of 2,400 cfs of attraction water is required. In order to meet varying capacity requirements under different pool elevations, pumps of 300-cfs constant capacity were selected. Eight units give a 300 to 2,400-cfs range in 300-cfs increments at a pool-to-pool head of 4 to 5 ft. Worthington Corporation furnished the eight vertical-propeller pumps with discharge connections 8 ft in diameter. The suction bells are 10 ft in diameter. See Fig. 2. The pumps operate at a constant speed of 105 rpm and are driven by 300-hp, 1,800-rpm vertical-induction motors through reduction gears.

Each 10-ft-diameter suction bell is suspended in an 18 x 25-ft suction pit which opens directly into the tailwater pool. Movable metal stop-gates are provided to close off each suction pit independently. See Fig. 2. Since the fish swim against the current, they move away from the pump suction.

The design and operation of the north shore fish facility is similar to that just described for the south shore, or powerhouse side, of the dam. However, the attraction-water requirements are considerably less. The total pumping capacity is 750 cfs at a pool-to-pool head of 3.5 ft, supplied by three pumps in increments of 250 cfs. Worthington Corporation furnished three 96-in. pumps of the same design as those furnished for the north shore station. These units operate at 92 rpm and each is driven by a 200-hp, 1,800-rpm constant-speed motor through reduction gears.

Pull-out design

Using ordinary pump designs, with the stationary diffuser placed above the impeller, it is evident that the impeller must be removed before the shaft can be pulled out. This, of course, can only be done from below. This operation makes it necessary to dewater the pit and then remove the suction bell and impeller from below. Each suction bell is 10 ft in diameter and weighs 2,000 lb, and the impellers, about 6 ft in diameter, weigh 3,200 lb. Removal from below, working within the confines of the suction pit, where overhead cranes are not available, would be a formidable task. Watertight access openings into the suction pit large enough to remove the components would have to be provided. It is evident that the ability to remove the rotating element from above would result in substantial savings in structure, labor and down time.

To meet this need, Worthington engineers developed the pump of "pull-out" design. See Fig. 2. With this arrangement, double-barreled construction is used in the diffuser and impeller section of the pump. The outer pump barrel is permanently grouted in position and the suction bell is suspended from it. The stationary inner barrel and diffuser are supported from above and the 8-ft discharge is connected to the butterfly valve. The joining surfaces between the inner and outer barrels are corrosion-resistant rings, to eliminate any possibility of "freezing" in position.

Pull-out design makes it possible to remove the entire rotating assembly from above, including the impeller, shaft, bearings, and stationary diffuser. By avoiding pit dewatering and making it possible to use overhead cranes, pullout design reduces down time and maintenance costs.

Trend toward turbine drive

Fish attraction is a relatively new pump application, yet certain trends are already becoming apparent. Through design refinements, the total quantity of attraction water is being reduced and the trend is toward fewer but larger, pumps. The required flexibility in flow is obtained by using variable-capacity pumps. Because of the extremely large size of some of the components, such as suction scoops and discharge elbows, these are often being incorporated in the concrete construction. With this arrangement the pump consists of the impeller and diffuser sections only.

The trend in driving power is toward the use of hydraulic turbines rather than electric motors. These meet the horsepower requirements of the larger pumps and, through governor control systems, can operate at variable speeds. The tailwater from these turbines is added to the pump discharge and accounts for about 10 percent of the total attraction-water requirement.

Reduction in the number of units required has made possible the installation of turbine-driven units in the powerhouse proper. This eliminates the necessity for a separate and expensive pumphouse. Because of the obvious advantages of the pull-out design, it is being incorporated in units of all sizes.

An examination of civil engineers' compensation

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As members of a great profession, engineers have dedicated themselves to the selfless service of mankind. But engineers, like other wage earners, have families to care for, children to educate, old age to provide for. Selfless service must not mean unpaid service, or poorly paid service, for to the extent that financial burdens occupy the mind and divide the energy, to that extent professional activity may suffer. Thus it is quite consistent with the ASCE objective that the Society should interest itself in the compensation of civil engineers. This interest is of long standing. The first published record during the last half century concerns the appointment, in 1912, of a Special Committee to Investigate the Conditions of Employment of, and Compensation of, Civil Engineers.

Credit for the first comprehensive survey of engineers' salaries made in the United States belongs to this committee. Early in 1914 it circulated a salary questionnaire to the membership of the Society, to which there were 4,796 replies. A supplementary mailing in 1915, covering members not contacted in 1914 and the membership lists of prominent local engineering societies, added 1,582, a total of 6,378. Of these, 5,059 were from ASCE members, a substantial percentage of the 7,707 on the membership roster (Feb. 1915).

The Committee's final report, dated November 15, 1916, was published as paper No. 1399, *Transactions*, vol. 81 (1917). It gives maximum, minimum, median and average compensation by years of experience, average compensation by geographical areas, average compensation by fields of employment, and comparisons between salaries paid to graduates and non-graduates, members of the Society and non-members. Some of these data are of sufficient interest to bear repeating here.

Average annual compensation, by years of experience, was reported as:

Years of Exp.	Annual Comp.	Years of Exp.	Annual Comp.
1	$1,187	20	$4,954
5	1,935	25	6,634
10	2,972	30	8,750
15	4,201		

The average annual compensation of all respondents (excluding those with over 50 years of experience) was $3,985. It is interesting to note that Society members averaged $4,140 compared with $3,390 for non-members. No significant difference between earnings of graduates and non-graduates appears until about the 10-year-experience level, when the graduates begin to pull ahead. Geographically, the highest average salaries were reported from the Middle Atlantic States, followed by the Central States, New England, the West and the South, in that order.

It is difficult to compare 1915 salaries with those of today because of changes in price levels and taxes. Such a comparison is of sufficient interest, however, to justify an attempt. Adjusting for the reduced purchasing power of the dollar and for federal and state income taxes, a married man with two children would have had to earn about $10,600 in 1958 to equal in purchasing power the $3,000 salary received by the average engineer with 10 years of experience in 1915. By comparison, the Engineers Joint Council survey of all engineers' salaries found the median 1958 income at the 10-year-experience level to be $9,100. The median salary of engineers engaged in design and construction was then $9,225; the median federal engineering salary at this experience level was $8,500; and that of state highway department engineers was $7,825. From these data, it appears that engineers today are earning less, in terms of purchasing power, than men of corresponding experience did in 1914-1915.

A comment from the 1916 report is particularly worth noting. It concerns the employer's responsibility to fix equitable salaries.

"The underpaid engineer does not always owe his failure to receive a salary commensurate with the importance or difficulty of his work to the ignorance or lack of appreciation of laymen, but it not infrequently is the fault of his engineering superior in the organization of which he is part .... The Code of Ethics ... lays special emphasis upon the relation of the engineer to his client, and upon that of competing engineers ... to each other, but ... it appears to lose sight of the need of guarding against underpaying as well as against underbidding."

During the decade and a half following the 1915 survey, the attention of the profession was occupied first with wartime activities and later with the pressures of an expanding economy in the free-swinging twenties. Little salary study activity was reported.

With the great stock-market collapse in 1929, engineers, like almost everyone else, entered a period of serious economic distress. Salaries were severely curtailed, and unemployment was widespread. The Government undertook a public works relief program that provided a modest number of jobs but drew criticism from many engineers because of the low rates of pay offered. In many instances engineers' compensation was little, if any, better than that of the laborers whose work the engineers designed and supervised.

The Society, speaking for civil engineers, objected to this practice but was told that there appeared to be no authoritative basis for determining what the rates should be. The Society promptly accepted the challenge, and in 1934 published a basic salary schedule covering one subprofessional and six professional grades. The salaries named in the schedule were derived from data collected by the Committee on Salaries from the highway departments of the 48 states in 1930, and from reports made in 1933 by the Local Sections. Supplementing the schedule was a set of adjustment factors to compensate for regional differentials and other factors. The study was promptly accepted as authoritative, and improvement in engineers' salaries was immediately effectuated by government.

Salary grading plan

With its 1934 effort as background, the Committee on Salaries in 1939 prepared and the Society adopted (with some modifications) a "Grading Plan and Compensation Schedule" covering the lower professional grades—one preprofessional and three professional. This was followed in 1944 by a more

TABLE I. Annual base salaries of civil engineers, 1943-1958

(Taxes are U.S. and Massachusetts state income taxes only.)

	Grade I		Grade II		Grade III		Grade IV		Grade V	
Source and Year	Gross	After taxes[1]	Gross	After taxes[2]	Gross	After taxes[3]	Gross	After taxes[4]	Gross	After taxes[4]
ASCE Schedule, 1944	$2,460	$2,289	$3,000	$2,719	$3,600	$3,285	$4,200	$3,849	$5,280	$4,720
ASCE Survey, 1959	5,000	4,187	5,430	4,693	6,100	5,362	6,900	6,138	7,800	6,864
Dollar increase, 1943-1958	2,540	1,898	2,430	1,974	2,500	2,077	2,700	2,289	2,520	2,144
Percentage increase, 1943-1958	102.5%	82.9%	81.0%	72.6%	69.5%	63.1%	64.3%	59.5%	47.7%	45.4%
Percentage increase, per year, cumulative	4.8%	4.1%	4.0%	3.7%	3.6%	3.3%	3.4%	3.1%	2.6%	2.5%

Tax status: [1] Single; [2] married, no children; [3] married, one child; [4] married, two children.

comprehensive "Classification and Compensation Plan" which defined duties, described requirements and established starting and full rate salaries for nine engineering grades based on extensive research by the Committee on Salaries and the Society's staff. This plan was superseded in October 1946 by a revised plan bringing the nine ASCE grades and the salary ranges associated with them into general agreement with the Federal Professional Grades P-1 through P-9.

It will be recalled that this period in American history was marked by a strong trend toward unionization of workers at all levels of activity, and by the development and acceptance of many practices which, two decades earlier, would have been condemned emphatically as socialistic. It will be recalled also that there existed at that time in the Society a group which, if it did not avidly embrace, at least accepted without much resistance the idea that under the Wagner Act, engineers were required to belong to a labor union. Only prolonged and vigorous opposition by those of our members to whom unionization of professional men was anathema held the Society from supine acquiescence. Unionism is still a threat to the profession, but today, thanks to Taft-Hartley Act provisions which the Society was largely instrumental in having included, engineers need no longer fear inclusion, willy-nilly, in a heterogeneous bargaining unit.

The Society never felt comfortable in the role of a salary arbiter, and it was happy to abandon this practice quietly after 1946. Salary surveys were resumed in 1951 and have been continued on a biennial basis since that time.

It is in order now to examine the growth of engineering salaries as the Society has recorded it since 1943, a period of unparalleled economic change. As a measure of this change, consider that in 1941, the last year before World War II, the value of our gross national product stood at about 120 billions. In 1958, it had climbed to 438 billions, increasing by 260 percent in that 17-year period. Personal income rose from about 100 billion in 1941 to 354 billion in 1958, a 250-percent increase. Per capita personal income rose from $750 in 1941 to $2,340 in 1958, an increase of 212 percent.

The Society made no salary survey covering 1943 salaries, but, as has already been noted, did adopt and publish, in 1944, a compensation plan for professional civil engineering positions in nine grades. Recommended starting and full-rate salaries are given in each grade. These recommendations are considered to be generally representative of the salaries paid civil engineers in 1943, since they were based on a study of "going" rates at the time.

The latest salary information available for comparison is that from the ASCE 1959 salary survey, which represents 1958 salaries. Median entrance salaries reported for the first five grades are compared with starting salaries from the 1944 schedule just described. The trends indicated by this comparison do not differ substantially from those found in the higher grades. Salaries have been compared as reported, and after adjusting for the effect of appropriate federal and Massachusetts income taxes. In computing taxes, it has been assumed that engineers in Grade I were single, those in Grade II were married, those in Grade III were married, with one child, and those in Grades IV and V married, with two children. The comparisons are shown in Table I.

(Delineation of ASCE grades will be found in the 1959 ASCE Salary Survey, available as *Proceedings* Paper 2188.)

It is to be noted that increases before income taxes were, for Grade I, 104 percent; for Grade II, 81 percent; for Grade III, 69 percent, for Grade IV, 64 percent; and for Grade V, 48 percent. The percentage increases after taxes were significantly lower, 83 percent for Grade I, 72 percent for Grade II, 62 percent for Grade III, 59 percent for Grade IV, and 45 percent for Grade V. The dollar increases before and after taxes are surprisingly uniform from grade to grade, indicating a tendency on the part of employers to maintain dollar rather than percentage differentials between grades.

Comparable earnings in industry and trade are shown in Table II. During the period studied, earnings before taxes (not wage rates) in the durable goods industries rose 83 percent; in non-durable goods, 120 percent; in all manufacturing, 92 percent; in building construction, 130 percent; and in retail trade, 160 percent. Earnings increases in these categories—after taxes—computed for a married man with one child, were 77, 102, 83, 114, and 141 percent. Note that only in Grade I did engineers' salaries increase at a comparable rate.

What about the rise in other indexes? The Bureau of Labor Statistics' Consumers Price Index rose 67 percent between 1943 and 1958, somewhat less than the salary rise, after taxes, for engineers in Grades I and II, but more than that for engineers in the higher

TABLE II. Annual earnings, including overtime, in various industries

	1943		1958		Cumulative Annual Growth Rate	
Class of Employer	Gross	After* taxes	Gross	After* taxes	Gross	After* taxes
Durable goods	$2,562	$2,420	$4,683	$4,281	4.1%	3.9%
Non-durable goods	1,775	1,769	3,915	3,568	5.4	4.8
All manufacturing	2,243	2,156	4,345	3,926	4.5	4.1
Building construction	2,505	2,376	5,750	5,075	5.7	5.2
Retail trade	1,295	1,295	3,370	3,122	6.8	6.1
B.L.S. Consumers Price Index	74.0	....	123.7	....	3.5	....

* Taxes computed for a married man with one child; data from Bureau of Labor Statistics.

grades. Since this index is a good indicator of the cost of living, it would seem that our higher grade people are not living as well today as they did in 1943, grade for grade.

These figures, of course, do not reflect changes in the engineer's earning power as his age and experience increase. Whereas the industrial laborer and the skilled construction worker operate within a wage structure fixed by union agreements, the engineer is limited only by his own capacity. If he lives out his normal span and retires at 65, the Engineers' Joint Council Survey indicates that he may today expect average lifetime gross earnings totaling about $430,000. The comparable figure in 1915 was $213,000 gross, indicating that expected lifetime earnings, before taxes, have about doubled in the past 45 years.

Fringe benefits

Thus far only direct salaries have been discussed, without considering the various non-salary benefits now becoming an increasingly important part of the engineer's compensation. In an effort to learn more about such benefits, the Committee on Salaries, in its 1959 survey, included a battery of questions designed to shed some light on this subject. Usable data were received from a total of 197 employers, including consulting engineers, contractors, state highway departments, municipalities and counties, railroads, utilities and industries. Benefits were reported as cost to the employer in terms of percentage of base payroll. The results are given in Table III.

It is unfortunate that earlier data on the subject of non-salary benefits are not available for comparison, making it impossible to indicate trends in this category. The Committee on Employment Conditions, with whose functions those of the Salary Committee have now been consolidated, expects to continue collection of such data.

Discussion thus far has dealt with historical matter. While this has a certain amount of interest of its own, our real concern must be with the future and what it holds for engineers. Productive speculation here properly begins by examining why engineers' salaries have failed to maintain the advantageous position they enjoyed before World War I.

That conflict was a milepost of great significance to America in many ways. For one thing, it marked more clearly than any other historical event our transition from an agricultural to an industrial economy. With that shift came rising industrial profits, the growth of unionism, and increasing claims by labor to a larger share of the national income. Wages climbed, in part because of union pressure, in part because the demand for labor grew faster than the supply, and in part because some segments of management recognized in higher wages higher purchasing power and increased sales.

Higher education became possible for many boys to whom it had been barred by economic stringency, and the number of engineers grew about as fast as the demand for their services. Because engineers were relatively well paid, and because the scarcity factor was absent, engineers' salaries rose more slowly than did workers' wages. Employers would not—indeed, could not—pay more when the men they needed were available at the going rate. It is proper to add that there is still no reason to suppose that the law of supply and demand has been repealed.

As professional men, we have rightly rejected unionism or other artificial controls on the supply of engineers, and have recognized in our licensing laws the right of every qualified person to enter the profession. Controlled scarcity is not apt to be a factor in determining engineers' salaries. The individual employer, from whom the impetus for a general increase in salaries must come, can and will pay more in this competitive age only if he is assured of more value for his dollar. The answer then must lie in better utilization of engineering manpower by the employer, in better performance by the employee-engineer, and in the production of better equipped engineers by our technical schools.

More training versus more engineers

We are going to have to open the door to better salaries for engineers by offering a better product. The following quotation from the 1916 report referred to earlier is pertinent:

"There is need of better trained engineers rather than of more engineers, a need more particularly of men who are better grounded in the fundamentals of the engineering sciences and who have at the same time acquired some knowledge of the economic or business aspects of engineering work, rather than of men who may have the greatest earning capacity on the day of their graduation."

The economic future of engineers appears promising for several reasons. Employers are making more efficient use of their engineers. The schools are turning out better men through improved curricula, longer courses of study and—most important—because they are getting a better selection of raw material. The demand for engineers on the whole is increasing, with every indication of continuing to do so. And the supply, predicted from college enrolments, is going to fall off slightly, at least in the immediate future. The employer is going to need more engineers, and is going to find them harder to get. All this points inevitably to higher salaries—probably much higher, barring war or economic disaster, in the next ten years. But let neither educator nor employer nor employee be complacent about it. Each must contribute of his best to bring this to pass.

TABLE III. Engineers' non-salary benefits, 1958

(Average cost as a percentage of base payroll exclusive of Social Security taxes)

	CLASS OF EMPLOYER											
	CONSULTANTS*		CONTRACTORS		STATE HIGHWAY		MUNIC. & COUNTY		RR'S, UTILS., INDUSTRY		TOTAL AND AVERAGE	
BENEFITS	Reports	%	Reports	%	Reports	%	Reports	%	Reports	%	Reports	%
Vacation	81	4.19	25	4.05	30	4.87	39	4.92	22	4.85	197	4.49
Sick leave	67	2.91	9	2.76	30	4.21	36	4.01	13	3.03	156	3.42
Bonus	54	6.61	16	9.66	0	....	3	2.03	3	5.85	76	7.04
Profit sharing	30	7.09	8	6.50	0	....	0	....	2	5.80	40	7.36
Retirement	22	4.16	10	3.56	26	5.03	35	7.22	18	6.12	111	5.60
Health ins.	50	1.20	12	1.20	1	0.50	12	1.71	15	1.68	90	1.34
Life ins.	42	1.09	13	1.13	2	0.31	6	2.60	14	1.39	77	1.25
Other	22	3.14	3	4.43	3	2.63	13	5.29	8	4.04	49	3.91
Average total	..	17.14	..	16.44	..	13.74	..	17.95	..	16.47	..	16.62
Range of total	4.30-49.10		3.85-38.85		8.80-22.30		4.30-50.08		5.00-30.82		3.85-50.08	

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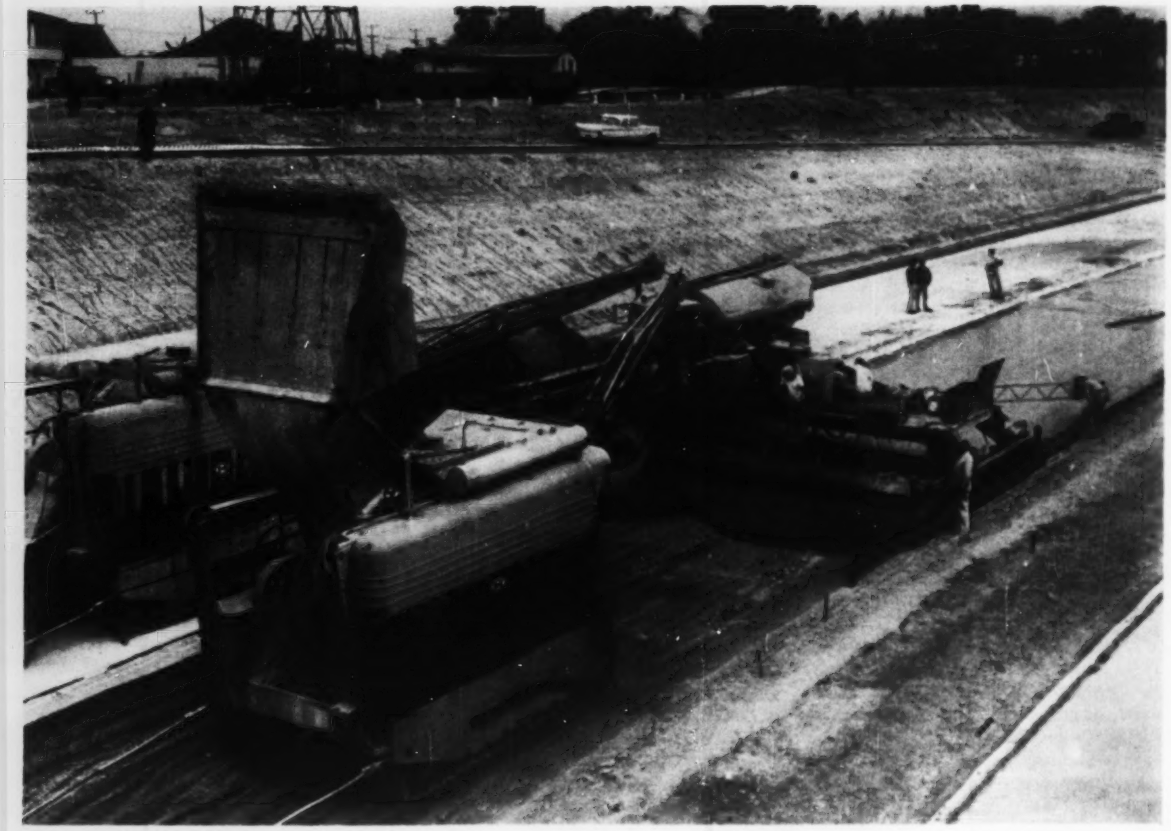
* One firm's data were omitted from the tabulation because of divergence of data.



One machine strikes off, vibrates and finishes in slip-form paving operation. Straight-edge checks slab smoothness.

Smooth surface from slip-form paving

R. M. INNIS, Senior Resident Engineer, District VII, Division of Highways, California Department of Public Works, Los Angeles

The first concrete paving to be performed by the slip-form method on a major freeway in Metropolitan Los Angeles was recently completed for District VII of the California Division of Highways. The route is part of the Harbor Freeway, an eight-lane divided facility extending about 22 miles from the center of Los Angeles to the San Pedro Harbor area. The project lies between 124th and 190th Streets, a distance of about 5 miles, and cost more than $8,000,000 to construct. The contract for the project was held by Ukropina, Polich & Kral and J. E. Haddock Ltd.

The Rex slip-form paver utilized on this project was manufactured by the Chain Belt Company of Milwaukee, Wis., and has been in use for several years on highway construction in other states. This type of slip-form paver differs primarily from the Gunnert-Zimmerman machine used in the northern part of the state in that the vertical alignment or grade is not dependent on wire or electronic sensing devices. The Rex machine depends on the subgrade and the straight-edge characteristics of the 22-ft tracks, on which it runs, to obtain the required smoothness. The screed or extrusion meter, as it is termed, is rigidly set for the depth of pavement required. It is obvious that a good subgrade is of prime importance in this method.

Cement-treated subgrade

The part of the Harbor Freeway on which the slip-form paver was used has two 48-ft concrete roadways separated by a 22-ft median. See Fig. 1. The outer 24 ft of each roadway has a 9-in. pavement and the inner two lanes an 8-in. Underlying the concrete pavement is 8 in. of untreated base, the upper half being cement treated to provide 4 in. of cement-treated subgrade, and 8 in. of select material. The material for the cement-treated subgrade is aggregate of ¾-in. maximum size. When this aggregate was mixed with 3 percent of cement, an average strength of 645 psi was attained in seven days.

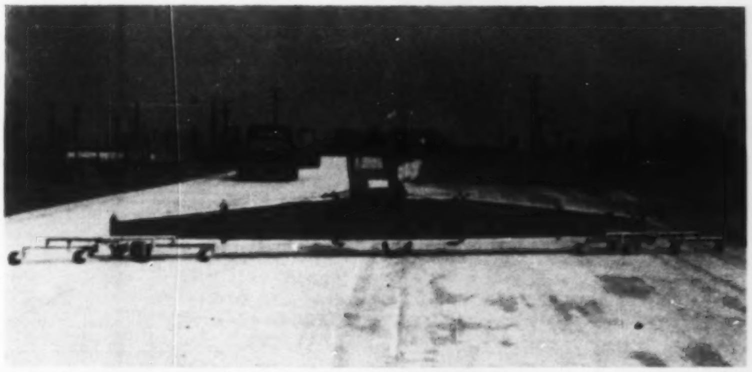
Grade stakes to the top of the cement-treated subgrade were offset 3 ft from the edge of the pavement and placed at 25-ft intervals along the line for each side of the 24-ft lane. One line stake and one marker lath indicating the percentage of crossfall were also set every 25 ft. For the initial 24-ft lane on the roadway, the contractor treated the subgrade with cement to a width of 27 ft. This not only provided a stable track path for the slip-form paver but also cleared the tie bars necessary for the adjacent lane. The tie bars were 30-in. lengths of ½-in. smooth round steel (Fig. 1).

The paving contractor, J. E. Haddock, used three sets of working hubs before the cement-treated subgrade was complete. The first set was placed to balance the material; the second set was positioned 4 in. down to check the bottom of the cement-treated subgrade after initial windrowing; and the final hubs were set to the top of the cement-treated subgrade for final grade, after mixing.

Utilizing one traveling Pettibone-Woods Roadmixer, one Cat 12 motor-grader, and one Cat 14 motor-grader equipped with a Preco automatic blade control, the contractor averaged 3,500 lin ft of cement-treated subgrade per day. Compaction was obtained by means of the usual steel and pneumatic-wheeled rollers. With the crossfall percentage noted on the marker lath, the blade operator using the automatic blade control could easily negotiate the transitions and superelevations.

Close tolerances met

The completed cement-treated subgrade was next profilographed each day, using the California Profilograph. This profilograph is a 25-ft machine, manually pushed, which records a scale profile of the pavement surface by means of a floating center wheel and necessary linkage. A typical profilogram or chart is shown in Fig. 2. By an accumulative count of the peaks outside the allowable 0.2-in. blanking band for a given length, a roughness index in inches per mile can be obtained. The permissible roughness for concrete pavement under the specifications of



The California Profilograph, which is hand pushed, records the surface profile.

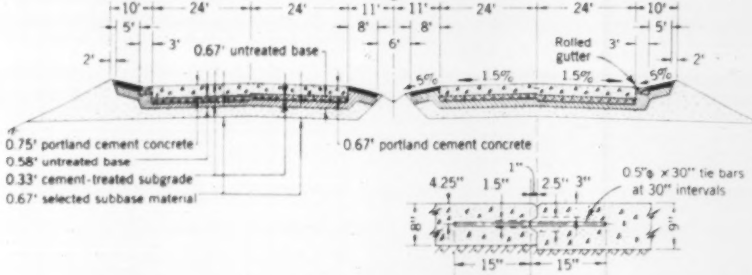

10'
24'
24'
11'
11'
24'
24'
10'
5'
8'
8'
5'
3'
6'
3'
2'
2'
0.67' untreated base
Rolled gutter
5%
1.5%
1.5%
5%
0.75' portland cement concrete
0.58' untreated base
0.33' cement-treated subgrade
0.67' selected subbase material
0.67' portland cement concrete
1"
4.25"
1.5"
2.5"
3"
0.5"ɸ × 30" tie bars at 30" intervals
8"
9"
15"
15"

FIG. 1. Typical section of the slip-formed pavement on the Harbor Freeway. Inset is an enlarged section at a construction joint in the center of the 48-ft width.

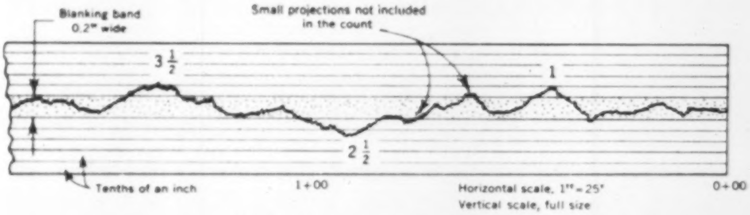


FIG. 2. Profilogram chart of 170-ft length of the Harbor Freeway. Dotted center section represents the allowable 0.2-in. tolerance. An accumulated variation of 7 in. per mile is permissible.

A sharp, clean pavement edge is exposed as the slip form moves forward.

Close-up of Rex paver shows hydraulic strike-off, vibrators, tamper bar and platform for placing center tie-bars.

the California Division of Highways is 7 in. per mile. A reading above 7 in. per mile means that the pavement must be corrected. On a concrete surface this is usually done by a multiple-diamond-blade grinder.

There is no profilograph specification for the subgrade. The machine was used on this project to assure acceptable smoothness. Results were a matter of great interest in view of the new slip-form paving method. The average reading for the job was 6.5 in. per mile on the subgrade. The smoothest cement-treated subgrade was profilographed at 3.1 in. per mile. As a result, the contractor had little difficulty in keeping the subgrade average under the 7 in. per mile that was specified for the concrete pavement surface.

Slip-form paver

The Rex slip-form paver, weighing about 38,000 lb, travels on two tracks, each 22 ft long. Each track is powered by a 3-hp d-c variable-drive motor. (These motors have since been replaced by 5-hp units.) The dual-drive arrangement enables the operator to regulate the speed of each crawler track to maintain alignment. Steering is guided by a plumb bob over a string line. The paver's primary power source is a 32-hp, Wisconsin four-cylinder, air-cooled engine driving a hydraulic pump and a 10-kw generator.

The concrete is placed on the grade between the front wings or side plates of the slip-form paver by two standard dual-drum Rex paving mixers. The concrete is initially struck off by a 24-ft hydraulically operated screed having 5 ft of fore-and-aft travel. This is part of the slip-form paver and is used to spread the concrete evenly across the roadway lane. Also, this screed has a provision for making vertical adjustments manually, which is useful for superelevations.

Behind the strike-off, and in front of the extrusion meter, the concrete is vibrated by a series of ten Maginnis vibrators of variable-frequency internal-spud type. These operate submerged, approximately $2\frac{1}{2}$ in. above the subgrade; they are powered by a separate 180-cycle a-c motor generator. The vibrators operated in a frequency range of from 5,000 to 10,000 vpm and readily obtained the specified 100-percent density.

Behind the vibrators and immediately in front of the extrusion meter is a tamper bar. This bar works to a lower limit about $\frac{1}{4}$ in. below the leading edge of the extrusion plate and insures that large aggregate particles are tucked under the screed plate so that they will leave no tears in the completed surface.

Controlled edge slump

The extrusion meter is a steel screed plate 42 in. long by 24 ft wide. The front edge is rounded and set about $\frac{1}{2}$ in. higher than the trailing edge, which is set to grade. The exact amount of pitch, which is adjustable, depends on the mix design, the water content and the like. The outer 6 in. of this plate, measured transversely, is adjustable and was turned up from $\frac{3}{8}$ to $\frac{1}{2}$ in. to compensate for mortar loss and resulting edge drop in the trailing forms. By adjusting the edges of the extrusion plate, the mortar loss and edge drop can be compensated for and a true section obtained. Behind the extrusion meter the surface is given a belt finish by means of a 24-in. oscillating rubber belt.

Paving was started by using two 16-ft sections of trailing form at each edge of the pavement. However, after the procedure was smoothed out, only one 16-ft trailing form on each side was found to be necessary. Trailing forms provide time for edging and such hand work as is necessary after the machine passes. The machine, the extrusion meter and the trailing forms are all set 24 ft wide. There was no appreciable narrowing of the section at any point.

On the later parts of the job, the contractor attached a chevron float behind the machine, so that it operated between the trailing forms. By this means the smoothness was improved and the labor of the hand finishers reduced.

Paving of the companion or second lane posed no great difficulty. The paver was blocked up on the grade side and the opposite crawler track rode the existing slab. One 16-ft trailing form was used and was diagonally supported from the back frame of the slip-form paver by a spring-loaded truss.

Keyways and tie bars

Keyways and tie bars were placed between the 24-ft strips throughout the job. The keyway sections, 20 ft long, with holes 30 in. on centers, were wired together on the grade and inserted into keeper plates or rods fastened to the side of the paver. The slip-form machine then traveled forward, the keyways passing on through. The keyways were metal and were left in place approximately 24 hours before being removed. A 4-ft length of slotted trail form was attached to the end of the trailing form on the machine. As the keyway passed through, the straight tie-bars were manually inserted in the holes of the keyway. The tie bars at the center of a 24-ft strip were placed manually in the concrete by a workman riding on a platform mounted on the front of the slip-form paver.

Edger tools attached to the end of the trailing forms performed the initial edging. A finisher on each side of the machine hand-floated the edge just ahead of the edger tool. With some additional modification of the chevron float and trailing forms, it is hoped to eliminate the hand floating at this point.

Behind the machine, finishers checked the slab longitudinally with 14-ft lightweight floats or straight-edges. Any large irregularities were taken out by finishers using a large bull float, worked from portable bridges across the slab. Very little of this work was required during the later parts of the job. The usual final edging and burlap dragging, to provide the desired surface texture, were then performed. Curing compound was mechanically applied by a machine straddling the slab, and all joints were sawed—at 15-ft intervals.

The daily production, using two Rex 34 E dual-drum mixers, averaged 1,550 cu yd per day, with a high of 2,100 cu yd per day. Production naturally depends on the number of structures that have to be crossed, the number of turnarounds, etc. Materials were proportioned through a fully automatic Johnson batch plant at the job site. It was charged by two Northwest crawler cranes.

Factors governing smoothness

The average pavement smoothness as determined by the California Profilograph was 5.9 in. per mile, well under the permissible 7 in. The smoothest run was 2.8 in. per mile. Aside from the smoothness of the subgrade, many fac-

One tread of paver operates on the completed lane. Trailing form, 16 ft long, is held by the pipe truss.

tors govern smoothness when using the slip-form method. Just a few are a consistent water content, steady progress of the machine, and proper placement of concrete.

To insure precise measurement of water in the mix, both mixers were calibrated and there was an electronic moisture meter in the sand bin of the batch plant. Variations in moisture at the plant were noted by the plant man and information sent out to the point of placement by the driver of a batch truck. The necessary water adjustments were then made on the mixers. Consistency of water in the mix is especially important with the slip-form method because a wet batch has a tendency to "boil up" at the rear of the extrusion meter. Conversely, a drier batch will produce a torn surface and possibly a pavement slump. The average slump was between 1 and 1½ in.

As in any paving work, steady progress of the paving machine is very important in securing smoothness, and the slip-form paver method is no exception. When it is necessary to stop, it is of prime importance to stop the vibrators, either at the same time or just before the forward progress of the machine is checked.

The concrete is placed on the grade between the forward guide plates of the slip-form paver. Uneven placement will cause not only roughness but a deviation in line as well. The mixer operators must time their placement to the forward travel of the slip-form and keep an even head of concrete in front of the strike-off.

Advantages and disadvantages

In comparing the slip-form method with the standard steel-side-form method of portland-cement-concrete paving, the major advantage is that the slip-form method is much faster. A further advantage is the smaller labor force needed and the reduced amount of equipment, eliminating the need for headers, spreader, tamper and finishing float machines. Naturally, a shorter operation requiring less labor and equipment will mean a saving for both the contractor and the state. However, the full benefit of the saving will not be realized until contractors gain the experience and "know-how" demanded by this relatively new method.

To continue the comparison, one or two disadvantages have been noted. With conventional side-form paving, there is an actual finished grade that can be seen and checked before the concrete is placed, whereas the slip-form method is dependent for good grade on the subgrade and the operation of the machine.

With the present method of preparing grade for the slip-form paver, a greater amount of effort and time are expended than with the conventional side forms, which provide a fixed visual reference. New construction methods are always difficult to introduce to personnel familiar with older methods which they have followed efficiently for years.

The contract has now been completed. The paving contractor, J. E. Haddock Ltd., and the State of California are both pleased with the finish and overall smoothness of the pavement. As more experience is gained with this type of paving, even better results are anticipated.

Other highway contractors are now indicating a desire for slip-form pavers, and at this writing, two large freeway contracts are under way using the same type of slip-form machines to place portland-cement-concrete pavement. The two contracts now using the slip-form paving method are a section of the San Diego Freeway in the San Clemente area, with Guy F. Atkinson Co. contractor, and a section of the Golden State Freeway in Burbank, with Ukropina, Polich & Kral, contractors. Both of these contracts are on Federal Interstate Routes.

It is anticipated that in the near future this method will become general practice, resulting in lower paving costs.

Final finishing operation proceeds at end of day. Note trailing slip-form at lower right. Men behind move up with a burlap drag.

ASCE NEWS

Boston Perfect Host to Convention

The Massachusetts Section was the perfect host to 1,917 members and friends of ASCE, gathered in Boston, October 10-14, for the 1960 Annual Convention of the Society. Some 150 papers were presented at the well attended technical sessions.

The week-long program included such highlights as the installation of Glenn Holcomb, engineering educator from Oregon, as 92nd president of ASCE. Professor Holcomb's address is briefed on page 33. At a luncheon meeting Prof. Karl Terzaghi, of Harvard University, the "Father of Soil Mechanics," was honored by establishment of the Terzaghi Award. On the same occasion Mr. Marston, acting for the Institution of Civil Engineers of Great Britain, presented to Dr. Terzaghi the Ewing Medal for "especially meritorious contributions to the science of engineering in the field of research." Appropriately, the technical papers presented at the Convention featured soils mechanics and research along with transportation, city redevelopment, and protective construction.

Honors conferred

Honorary membership in ASCE, the Society's highest honor, was bestowed on Guy F. Atkinson, heavy construction contractor of South San Francisco, Calif.; Solomon C. Hollister, dean of the College of Engineering at Cornell University, Ithaca, N.Y.; and Frank Kerekes, dean of the faculty at the Michigan College of Mining and Technology, Houghton, Mich. Earlier a fourth honorary membership was conferred on Fred C. Scobey, consulting engineer of Berkeley, Calif., whose illness prevented attendance at the ceremonies. Brief biographies of the recipients appeared in the October issue of CIVIL ENGINEERING.

The John Fritz Medal, sponsored by the five Founder Societies and awarded annually for notable scientific or industrial achievement in engineering, was won this year by Stephen D. Bechtel, F. ASCE, of San Francisco. This distinguished award was presented to Engineer-Contractor Bechtel at the Society's Annual Dinner just a few hours after his firm had completed and formally turned over to the Commonwealth Edison Company the 180,000-kw Dresden Nuclear Power Station in Illinois.

An unusual number of engineers from outside the U.S. attended the sessions, adding knowledge of engineering in other areas to the discussion. One group of eight German engineers on a five-week U.S. tour, under the auspices of the Council for International Progress in Management, took an active part in soils and foundations sessions.

At the general Wednesday morning meeting retiring President Marston thanked those who have done the work of the Society, especially in the successful drive for funds for the United Engineering Center. As ASCE representative on United Engineering Trustees—the group that administers the building for the engineering societies—Vice President Molineaux of Zone I reported that ASCE was the first of the original Founder Societies to reach its quota. About two-thirds of the Local Sections have met their goals; 82 percent of ASCE pledges have been paid so there is no present concern about meeting our commitment in full. Mr. Molineaux singled out Past Presidents Howson, Friel and Marston and Executive Secretary Wisely as having contributed greatly in pushing the UEC campaign to a successful conclusion with resulting increase in ASCE prestige.

Mr. Wisely commented that fund raising had extra beneficial effects on the membership in unifying it and promoting growth. This year saw the Society's fourth largest annual increase in membership, with 2,400 added to the rolls.

At the general meeting, the Society's coveted honors and prizes were presented to most of the recipients named in the October issue of CIVIL ENGINEERING. A few could not attend, and the awards will be presented to them at convenient future ASCE meetings.

The Board of Direction met, as customary, during the Convention. An outstanding action was the appropriation of $10,000 for research to match

Vice President Charles Molineaux (left), ASCE representative on United Engineering Trustees, talks about the United Engineering Center with Executive Secretary William H. Wisely and Director Trent Dames, of the Los Angeles Section. The L. A. Section made a whirlwind finish to get into the filled-quota group on contributions to the new Center.

Participants in a Protective Construction session are (in usual order) Rear Admiral E. J. Peltier, Chief, Navy Bureau of Yards and Docks; Maj. Gen. A. M. Minton, Director of Civil Engineering, Air Force; Col. W. D. Alexander, Air Force Ballistic Division; and Brig. Gen. Clarence Renshaw, Assistant Chief of Engineers for Military Construction, U.S. Army.

Emory Ireland (left), who most ably handled the technical sessions at Boston, is pictured at the Convention with Weston Evans, ASCE Director for District 2, and Roger Williams, luncheon chairman.

a grant from the Engineering Foundation. Board of Direction actions are briefed on page 55.

Instructive luncheons

Perfect weather and bright autumn foliage, in combination with the hospitality of Massachusetts Section members and their ladies, made the Convention most enjoyable as well as technically rewarding. The Boston Society of Engineers, oldest technical group in the Americas, invited the ASCE visitors to a dinner where Mayor Collins told of progress and plans for rebuilding the downtown area of Boston.

W. F. Keesler, Boston banker, addressing the first luncheon meeting put the problem of urban renewal into words of one syllable, "People must live in cities or be able to get into them." Either requires a change and renewal. Banker Keesler commented:

1. That we are creating waste of existing facilities by construction of nearby new ones.

2. Traffic can best be aided by aiding mass transport as we have highways and airports.

3. Money should come from local areas.

Enlarging on the theme that "this is the most explosive age in all history," Rear Admiral E. J. Peltier, Chief of the Navy Civil Engineer Corps, in another luncheon talk said that our very survival is dependent on maintaining scientific and engineering supremacy. "Our country is indebted not only to the scientists who successfully split the atom, but to the engineers who took it out of the laboratory.

The export of civil engineering and construction know-how in the 1960s may well be a controlling element in our national security, Brig. Gen. Alden K. Sibley, until recently Division Engineer of the Army Corps of Engineers' New England Division, told the Friday luncheon session. General Sibley stated, "The construction of roads and bridges, water supply and utility systems, schools and hospitals in the smaller nations of the free world is perhaps the strongest bulwark against the inroads of international Communist aggression." It is expected that there will be a five-fold increase in the export of engineering and construction talent to the underdeveloped nations of the free world. The general left immediately after his talk for a new assignment in Saigon, Vietnam, where he will serve as deputy chief of the Military Assistance Group to that country.

Prestige race not for U.S.

Featured speaker at the Awards Luncheon was Dr. James R. Killian, chairman of the Massachusetts Institute of Technology Corporation and former Special Assistant to the President for Science and Technology. Drawing on his experience, Dr. Killian commented on five widening responsibilities of the engineer. His significant talk is briefed elsewhere.

Cornelius Wandmacher, associate dean of the College of Engineering, University of Cincinnati, reported on the Conference on Civil Engineering Education, held at the University of Michigan last July. The conference was sponsored by ASCE with the American Society for Engineering Education and The Cooper Union, under a grant from the National Science Foundation.

At the conference, an "interchangeable core" of, perhaps, three-fourths of the course of study was proposed—to result, perhaps, in a Bachelor degree. The scheme could be built on at the graduate level in either of two ways: (1) a research and teaching direction through an M.S. to a Ph.D., or (2) in an engineering practice option to a civil engineering degree—a Master and perhaps a Doctor of Engineering.

G. Brooks Earnest, president of Fenn College, Cleveland, Ohio, at a luncheon session, questioned proposals for extension of engineering study to five years or more. The proposal to leave the special engineering fields almost entirely to the graduate schools has some shortcomings, he said. One easy way to give a more thorough training in the social sciences and humanities, as well as the basic sciences is to add another year to the engineer's undergraduate curriculum. Another is to leave special engineering almost entirely to the graduate schools.

Following his induction as new President of ASCE, Prof. Glenn W. Holcomb (left) received an unexpected honor in the form of a "friendship award" from many of the civil engineering students he has taught at Oregon State College. The presentation was made by John G. Moffatt, a former student and now a consulting engineer in Long Beach, Calif. The citation accompanying the award—signed by over 800 former students—hailed Professor Holcomb, "For outstanding service in engineering education during the years 1920-1960."

The Theodore von Karman award, which recognizes distinguished achievement in engineering mechanics, was presented at the Convention as Dr. Von Karman (at left) looks on. Next is recipient, Prof. William Prager, of Brown University, with Prof. Arthur T. Ippen of MIT and ASCE President Frank Marston.

"Proposals to make the student go to school longer are fundamentally too easy to be right. We may do much better to subject engineering education to analysis and synthesis," Professor Earnest commented. "The engineer employed in industry is likely to avoid theoretical work. The professor in the university is likely to take pride in the deliberately impractical. . . . The best we can hope for is a constant intellectual process working toward possible . . . solutions.

Conditions of Practice sessions

The participation in professional society activities of engineers employed by public agencies was discussed at a Department of Conditions of Practice session. Lead-off speaker was John G. Duba, administrative assistant to the Mayor of Chicago, who reported a survey of the attitude of the employer on professional activities of the staff.

Almost no public agency discourages participation in professional activities; only a few actually encourage it. Most often lack of interest on the part of the employer can be attributed to lack of expressed interest of the employee. Perhaps two-thirds of the employers want their engineers to belong to professional groups but frequently only the outstanding ones are encouraged to participate.

Often, said Mr. Duba, the employee is not active at local level in professional societies and then does not understand why he is not permitted to go to a convention at some glamorous location. The local authorities fear political criticism for allowing employees to go on a junket. However, where participation may bring favorable publicity to the agency, authorization for convention time and expense is more likely to be granted.

Dr. Karl Terzaghi (center), received a standing ovation as President Marston presented the Ewing Medal to him for the British Institution of Civil Engineers. Jorj O. Osterberg, chairman of the Executive Committee, Soils Mechanics Division, is at right.

"Writing technical papers for publication in local trade and professional periodicals should be recognized as an important part of an engineer's professional development" was quoted by Frank A. Butrico, chief, Engineering Resources Program, U.S. Public Health Service, in speaking for employees. Writing should be considered an obligation of the engineer. It should be not only technical but in a popular vein, understandable to the layman so he will know the work and problems of engineers and support their needs. Mr. Butrico pointed out that another important field item is professional and technical organizations, and that participating in their activities as well as joining them is important.

John E. Wright, of Armco Drainage and Metal Products, Inc., Indianapolis, presented the "Attitude of the Public as Beneficiary." The public needs further education to understand that engineers save money where others have started squandering it. And engineers need to get further into politics so the average person will know more of what they do and can do. Emphasizing that no one is trained as a politician, Mr. Wright said that engineers could do at least as well as others in this field, with substantial saving for all.

A session on employment conditions confirmed what engineers have long suspected—that average engineering income, after taxes, does not permit those in the higher grades to live as well as they did in 1943. The younger men get a better break. A paper, by Oscar S. Bray of Boston, outlines civil engineers' compensation since 1916 and provides comparison with income of others. It appears on page 41 of this issue.

A companion paper, by Irving F. Ashworth of the New York City Department of City Planning, reported a survey of environmental conditions in private and public engineering offices. It was found that: (1) registration generally is encouraged, (2) time is allowed for professional activities, (3) half of those contacted have some provision for retirement income, and (4) health insurance is almost universal. These and seven other items on which fifty firms supplied answers will be given detailed treatment in an early issue of CIVIL ENGINEERING.

Research

Research was a major topic at the Boston Convention with almost every speaker mentioning either its need or value in his field. Wednesday afternoon was given over exclusively to a session on research. In general, the theme was that much more research is imperative. The big question was who should do the work and with whose money.

Nathan H. Newmark, head of the Department of Civil Engineering at the University of Illinois, gave reasons why research in engineering institutions is important. In training students and undergraduates it creates an active atmosphere. It helps to retain the staff and keeps them up to date (those relying on "practice" may be 5 to 10 years behind—and so are their students). Research is a big factor in financing graduate studies—some 85 to 90 percent of the graduate students have some form of subsidy. Research also has a big part in the prestige of the institution and its professors. A trained researcher, said Professor Newmark, is better than an eminent authority. Research should be uncontrolled and unrestricted, with full publication of results permitted.

Lt. Gen. Arthur G. Trudeau, chief of the U.S. Army's Research and Development program, told a general meeting on research that industry should review its policies with respect to research and stop leaning so exclusively on government support in this field. The government now pays for more than 50 percent of the research in this country. If American technology is to continue to accelerate—"and it must to outperform the Reds," he interpolated—greater emphasis must be placed on basic research for new scientific knowledge and on applied research for new hardware items. "Our national ability to provide adequate defense in the late 1960s and the 1970s will be determined by the research and development effort our country is willing to support today." General Trudeau advocated grants instead of contracts on research to permit researchers to follow promising leads.

An example of what comes from research was given in a top brass presentation of protective construction practices of the U.S. military forces at an Engineering Mechanics Division session. Some of these papers will appear in CIVIL ENGINEERING.

Rear Admiral E. J. Peltier, chief of the Navy Bureau of Yards and Docks, told something of what is being done to exclude initial and residual radiation from shelters. Simplicity is a prime virtue, but closing devices to prevent blast overpressures in facilities must be almost instantaneous. The Navy has a unit that will close in half a second and provide resistance up to 500-psi overpressure on a 12-in.-dia opening and 175 psi up to a 48-in. opening. Research has shown that survival probability from ground shock effects does not increase appreciably with increasing depth of cover up to several hundred feet of depth.

In a paper prepared by Brig. Gen. W. E. Leonhard, of the Ballistic Missile Division of the Air Research and Development Command of the Air Force, the economics of "hardening vs. dispersal" were brought out. For example, to deploy a squadron of missiles so only one could be destroyed per enemy weapon would require separation by 15 miles. For 40 missiles 600 miles of road and communication would be needed. With protective structures, the distance between launchers could be 3 to 5 miles.

Maj. Gen. A. M. Minton, Director of Civil Engineering for the Air Force, said it would be the greatest military victory in history if we can convince the enemy that if he attacks, even with a surprise blow at a time of his own choosing, he would surely be defeated. To prevent this first blow being made we must devise weapons and protective techniques that will enable us to survive and strike back effectively. Our offensive weapons will be the primary target of any enemy attack. In commenting on dependence on research because of the ban on nuclear testing, General Minton said, "I believe that if there is any single mistake that has been made during the past four or five years concerning protective construction, it has been the mistake of underestimating the ability of engineers to design and construct adequate hardened facilities. I think the strides we have made in overcoming the problems have been little short of miraculous."

Brig. Gen. Clarence Renshaw, Assistant Chief of Army Engineers for Military Construction, summed up the big problem of all the services, "To provide hardening for all facilities would result in prohibitive total costs. Therefore, hardening must generally be restricted to only selected facilities of vital importance, which must remain in place due to their mission or which are not suitable for duplication or dispersal. The provision of personnel shelters on a wide-scale basis, even though this may be accomplished at nominal cost, will still require monies in excess of those now provided for facilities which are already as austere and minimum as we can make them."

Excavation with nuclear explosives

Paralleling military use of and protection from nuclear explosives are the possible civil and peaceful uses for large-scale excavation, as outlined by Gerald W. Johnson, of the Lawrence Radiation Laboratory, Livermore, Calif. Chemical explosives normally are used to break up material for easy handling; only infrequently have they been used to actually displace materials. The Soviets have used such "diffusion blasting" for large-scale earthmoving. The cost of excavating a trench or moving material down a slope may be in the 10 to 35 cents per cu yd range in the not too distant future. Radioactivity released to the atmosphere by a nuclear-cratered detonation varies strongly with the depth of burst, but it appears possible to hold it to 1 to 2 percent of the gross radioactivity. Plans are being made for a possible excavation project on the northwest coast of Alaska, primarily to provide experimental data and, incidentally, to provide a small harbor.

Several engineers from other countries attended the Convention. Reading left to right are James C. Costello, of Dublin, student winner last year of the U.S. Steel Corp. bridge design contest; Heinz Muhs of Berlin; and S. H. Kuhn from the Union of South Africa.

Commuter transport

Engineers got a new insight into the rail commuter problem from a talk by Walter Patchell, a vice president of the Pennsylvania Railroad. He told a City Planning Division session each lane of railroad track can handle as many people per hour as 20 lanes of superhighways in the manner in which people are now using them. And a 10 percent reduction in mass transit will produce a 42 percent increase in automobile travel. Over two-thirds of the land in downtown Los Angeles is now streets, highways, and parking facilities. Mr. Patchell asked his audience to consider the effect on the tax base of their own town of having half the area for streets and half the remainder for parking. His paper will appear in an early issue.

Capital cost of new mass transport should not be charged against the fare structure, S. H. Bingham, former exec-

Father Daniel Linehan, of Boston University, gave the invocation on Tuesday. With him is Rear Admiral E. J. Peltier, chief of the Navy Bureau of Yards and Docks, with whom Father Linehan worked on seismology in the Antarctic recently.

utive director and general manager of the New York City Transit Authority, told the same group. Fares should be based on operation cost alone, with money for construction and equipment obtained from other sources. He advocated the use of a modern, high-speed mass transit system using lightweight cars. These would operate overhead except perhaps in the central business district of a city. Mr. Bingham emphasized the need for a Federal Department of Transportation, which would be responsible for the development of a national policy based on fair competitive standards for all forms of transportation.

Joseph Barnett, of the U.S. Bureau of Public Roads, told a joint City Planning-Highway Division session that it is necessary to learn more of human behavior on the nation's roadways before plans are made for a future highway system. Acknowledging that accident reporting at the present time is done by officials whose prime purpose is law enforcement, Mr. Barnett said that what is needed is accident and operating reporting with special emphasis on causation, both on the part of the drivers and on the physical condition of the highway. As more is learned of human behavior on freeways ideas change, so it does not seem wise to prepare plans too many years in advance of financing ability, except for the reservation of right-of-way.

Expressway savings

Proof that good roads pay was offered in a paper presented by Evan H. Gardner, director of economic research for the Pennsylvania Department of Highways. A detailed analysis of time saved and advantages gained on portions of the Schuylkill Expressway in Philadelphia showed that "expressway earnings" amounting to $18,128,000 annually, would repay the original construction cost of $57 million within three years. It was further calculated that on a capital recovery basis for thirty years at 6 percent interest the net earnings would have justified a construction cost of four and a half times the actual amount, or a unit cost of $13.4 million per mile. This saving was made up of savings in time of 8,721,000 vehicle hours at a rate of $1.35 per hour for passenger cars and $3.00 per hour for trucks and buses, or a combined average of $1.56 per hour which amounted to nearly $13 million. There was a little more than 7,000,000 vehicle miles of distance saving, estimated at 5.28 cents per vehicle mile, which amounted to nearly $400,000. Savings in operating on interstate highways over travel on urban arterial streets amounted to nearly $3 million, while reduced accident costs were estimated at about $2 million.

Another speaker pointed out the surprisingly high maintenance costs of heavy volume freeways. Carlton C. Robinson, of the Automotive Safety Foundation, Washington, D.C., told the engineers that the cost per mile on a freeway with heavy traffic is up to $30,000 a year, with less than 15 percent of this for physical maintenance of pavements and structures. The remainder goes for fringe benefits, such as clean-up, landscaping, and traffic services. Police services cost another $30,000 per mile per year. Operation of today's freeways should be studied for clues to better designs for tomorrow.

Sanitation—big problem for small towns

The construction grants program of the Federal Government has been an "impelling force" in the construction of pollution abatement projects, mainly in communities of less than 50,000 population, a Sanitary Division session was told in a paper presented by Gordon E. McCallum and David H. Howells, of the U.S. Public Health Service. More than 2,200 projects have been approved under a Congressional act of four years ago, which provided for the appropriation of $230 million to help out cities and towns with sewage pollution problems. Grants-in-aid amounting to $184 million have been made in support of construction costing well over $1 billion. Every dollar of Federal aid has been matched by $4.70 in local funds.

An inventory in 1957 showed that

Construction men heard John A. Shaw (left), of the Lock Joint Pipe Co., speak on the installation of concrete pipe all around the world. C. A. Richardson (right), of the Perini Corp., described driving a shield tunnel under Boston Harbor. Carl Jansen, of the Dravo Corp., presided.

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J. W. Leslie (left), of the U.S. Army Engineer Division, New England, told a Power Division session that Passamaquoddy Dam can be built. Big problem is constructing dams in swiftly flowing deep water. M. P. Aillery (right), chairman of the Division executive committee, presided.

In photo at left, Richard Dougherty, Past President ASCE, and Wm. N. Carey, retired Executive Secretary of ASCE, talk with Brooks Earnest of Cleveland at the Convention.

Prof. F. E. Richart, Jr. (left), winner of the Thomas A. Middlebrooks Award for the second year, receives his prize from President Marston while Director Rutledge looks on.

more than 5,400 communities serving 48 million people discharged raw or inadequately treated wastes to the nation's waters. Nearly nine-tenths of these communities are towns of less than 10,000 population. The problem has been the cost of providing pollution abatement facilities. The annual per capita cost of a treatment plant in a town of 10,000 is twice that for a city of 100,000 and for a town of 1,000 population is three and a half times as much.

Robot on the Ohio

An electronic robot to aid in safeguarding streams from pollution was placed in operation at Cincinnati on September 15 by the Ohio River Valley Water Sanitation Commission, Edward J. Cleary, executive director and chief engineer of the commission, reported to the engineers. The system, called the Orsanco Robot Monitor, consists of three integrated units—an analyzer and transmitter, a telemeter receiver, and a data-logger and transcriber. It is the culmination of several years experimentation in devising a practical means for round-the-clock observation. The analyzer units may be located at many points along the Ohio River where quality checking is desired. Electronic equipment performs the tests and relays information to central headquarters in Cincinnati for evaluation.

Passamaquoddy still a prospect

Of considerable interest in the Power Division program was a talk by J. W. Leslie, of the U.S. Corps of Engineers New England Division, on the Passamaquoddy Tidal Power Plant. The physical plans and data are similar to those reported by Gen. Alden K. Sibley at the ASCE Convention in New York in 1958 and printed in the December 1958 issue of CIVIL ENGINEERING. There are new data on costs and an extension of the idea of a supplemental hydraulic power plant at Rankin Rapids on the St. Johns River in Canada. "Quoddy" could produce 1,843 million kilowatts annually at an average 11-ft head through thirty 10,000-kw units using the favored two-pool scheme. Dependable capacity is 95,000 kw; cost is estimated at $530 million. However inclusion of the Rankin Rapids plant—400,000 kw installed capacity at a cost of $150 million—would provide 550,000 kw of firm power from the combined plants and produce about 3 billion kw annually. Mr. Leslie reported the project economically feasible for the U.S. half of the cost on a 2½ percent financing rate set up by the Bureau of the Budget. It is not economical for Canada when computed at a 4⅛ percent rate. There will be a market for the power by the time it can be made available, Mr. Leslie concluded.

Nuclear power was the subject of several papers. From the Army Engineers came a report on a 1,500-kw, plus 1,000 lb of steam per hour plant, on the Greenland Icecap. Scientific and engineering data from this installation are expected to aid polar—and solar—living. The Navy plans a floating nuclear power plant that can be towed anywhere and set up ready to go to work. A 5,000-kw plant can be put in a 25-ft-diameter cylinder 100 ft long. An Army Corps of Engineers reactor at the Watertown, Mass., arsenal is being used for fundamental research into matter.

Research briefs

The Structural Division put a dozen speakers on each of two sessions for 12-minute reports on research. Typical was this brief from T. R. Higgins, of the American Institute of Steel Construction. "Briefly looking to the future, or looking over the shoulders of

Winner of the J. C. Stevens award for his discussion of a paper on hydraulics was Hans A. Einstein, right, son of the renowned scientist. At left is Past President J. C. Stevens, on his way back to Portland from a trip around the world.

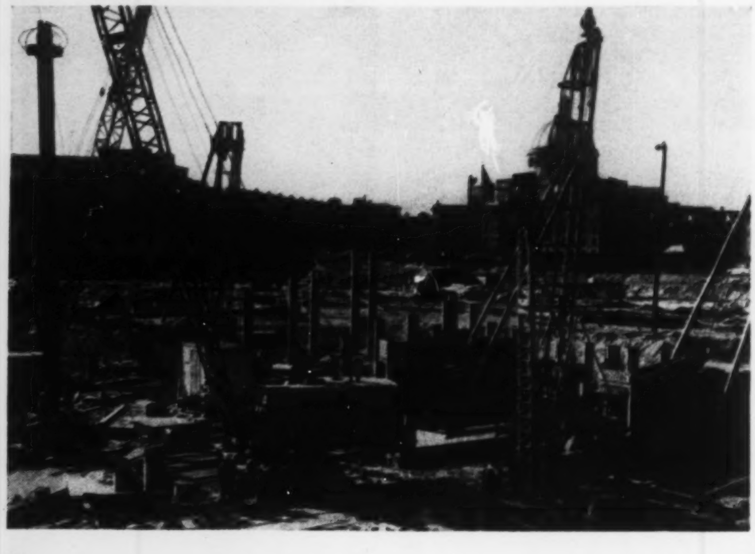
President Marston (at left) congratulates new Honorary Members of the Society: Dean Solomon C. Hollister of Cornell; Dean Frank Kerekes of Michigan College of Mining and Technology; and Guy F. Atkinson, engineer-constructor of San Francisco. Fred C. Scoby, fourth new Honorary Member, was not present.

A session on Engineers in Public Practice brought together (left to right) John G. Duba, administrative assistant to the Mayor of Chicago; Frank Weaver, Federal Power Commission; Frank A. Butrico, U.S. Public Health Service; and John E. Wright, Armco Drainage and Metal Products, Inc.

our research people, we see new structural steels, new and more efficient rolled structural shapes, developments in the use of prestressed steel members and structures, girders having low-strength steel webs and high-strength steel flanges, composite construction utilizing new materials with steel, corrosion-resistant clad-steel structural members, the use of adhesives for joining steel, and many more."

Space does not permit even brief mention of most of the papers presented at the meeting. Many of them will appear in ASCE publications.

Drilled-in-Caissons, used for foundations of the projected Prudential Building in Boston, were described by Donald Ball, soils engineer for Metcalf and Eddy. (Western Foundaton Corp. photo.)



Thanks to Section

Outstanding service to the Convention and ASCE was given by many members of the Massachusetts Section. William H. Mitchell as general chairman and Charles H. Norris, president of the Massachusetts Section and vice chairman of the Convention, took the lead in the well organized arrangements for the comfort and entertainment of guests. Cranston R. Rogers succeeded in getting out-of-towners tucked into hotels; F. T. Sendker and a group of greeters guided all comers through registration painlessly. Emory Ireland efficiently ran a large number of concurrent technical sessions, while A. Russell Barnes handled the general meetings.

Luncheon meetings were the responsibility of Roger Williams, with Robert A. Snowber in charge of the entertainment functions. Bruce Campbell promoted the very good attendance, Paul S. Crandall managed the field trips, and John L. Lowe worked with the large number of students who came to the Convention. Budget and finance were kept under control by John H. Hession.

An innovation in social programs was the Sunday afternoon tea to welcome members and guests to Boston. The tea was quite successful in instilling the idea that Boston and its engineers are friendly. The Icebreaker Party on Monday evening, the Award Dinner, and the Smoker were capacity affairs, and all came off in an atmosphere of good fellowship.

The ladies enjoyed a full week of historic New England with activities planned by Mrs. Arthur T. Ippen, Mrs. Charles H. Norris, and their efficient committees. Planned tours took them to interesting spots in Boston and its environs at times when the engineers were occupied with the technical sessions.

The total attendance of 1,917 included 450 students, led by a contingent of 85 from Northeastern University, 45 each from Tufts and M.I.T., 35 from Worcester Polytechnic Institute, and 30 from the University of New Hampshire. The other New England engineering schools were also represented, as were eighteen other schools —some from as far away as Illinois.

Board of Direction Meets in Boston

The Board of Direction met during the first days of the Boston Convention to transact official business of ASCE. Actions of general interest to the Society are briefed here.

Grants for Research Department

The Board voted to accept a $10,000 grant from the Engineering Foundation to be matched by the Society for the purpose of setting up an expanded program of civil engineering research during the year ending September 30, 1961. Authorization was also given to provide the necessary matching funds from the 1960-1961 budget.

Report on Redistricting

Extensive discussion of proposed changes in ASCE Districts and Zones resulted in a decision to receive the report of the Committee on Districts and Zones and to discharge the committee with appreciation. A new committee, to be set up under the present provisions of the Constitution and By-laws, is authorized to prepare a plan and make positive recommendations not later than October 1962. If necessary, the plan may include proposals to amend the Constitution and By-laws.

The new committee will consist of Mason G. Lockwood, as chairman, Louis R. Howson, Jewell M. Garrelts, and Graham P. Willoughby.

Committees Authorized

The Board voted to authorize a Research Council on Air Resources Engineering; to establish a Water Resources Coordinating Committee on a continuing basis; and to continue its support of the National Industrial Zoning Committee.

Manual of Ethics

An interim report on the Manual of Ethics was referred back to the Committee on Professional Practice with the request that it consider newly presented material. The members of the Board commended the Committee for the diligent and persistent manner in which it is attacking this difficult problem. Board members agreed to send written comments to the Committee on Professional Practice.

Civil Engineering Education

It was voted to underwrite the publication of 1,000 copies of the Proceedings of the Conference on Civil Engineering Education, which was held at Ann Arbor, Mich., in July 1960, provided funds are not available for this purpose from the National Science Foundation or other source. (The Proceedings will be announced in CIVIL ENGINEERING when they are available.)

Student Club

The Board authorized the formation of an ASCE student club at the Pennsylvania Military College at Chester, Pa. The group was organized to gain the advantage of ASCE affiliation and as a forerunner of a regular Student Chapter.

Local Section Conferences

Spring conferences were authorized for Phoenix, Ariz., during the ASCE Convention; Spokane, Wash., during the Pacific Northwest Council meeting; either the New England or District 3 Council meeting; the District 16 and District 9 Council meetings. Faculty Adviser conferences were authorized for Atlanta, Ga., spring 1961 (20 Chapters) and Phoenix, Ariz., April 1961 (25 Chapters).

Future Conventions

The Board accepted the invitation of the Northwestern Section to hold a convention of the Society in Minneapolis-St. Paul in May or June 1965. The scheduled Conventions follow:

April 10-14, 1961	Phoenix, Ariz.
Oct. 16-20, 1961	New York, N. Y.
Feb. 19-23, 1962	Houston, Tex.
May 14-18, 1962	Omaha, Nebr.
Oct. 8-12, 1962	Detroit, Mich.
Feb. 25-Mar. 1, 1963	Atlanta, Ga.
May 20-24, 1963	Milwaukee, Wis.
Oct. 7-11, 1963	San Francisco, Calif.
Feb. or Mar. 1964	Cincinnati
May 11-15, 1964	Salt Lake City
Oct. 19-23, 1964	New York
May or June 1965	Minneapolis-St. Paul
Oct. 1965	Kansas City, Mo.
Oct. 1966	Philadelphia

Joint Activities

Some improvement has taken place in the financial operation of the Engineering Societies Personnel Service. It is still planned, however, to complete a comprehensive study of ESPS with a view toward possible reorganization.

Daniel Mead Prizes Awarded

The Board voted to approve the award of the 1960 Daniel Mead Prizes to James M. Abernathey (Associate Member Prize) and Jack K. Keiser (Student Prize). Another Student Prize (second order of merit) was awarded to Clayton H. Stimmel.

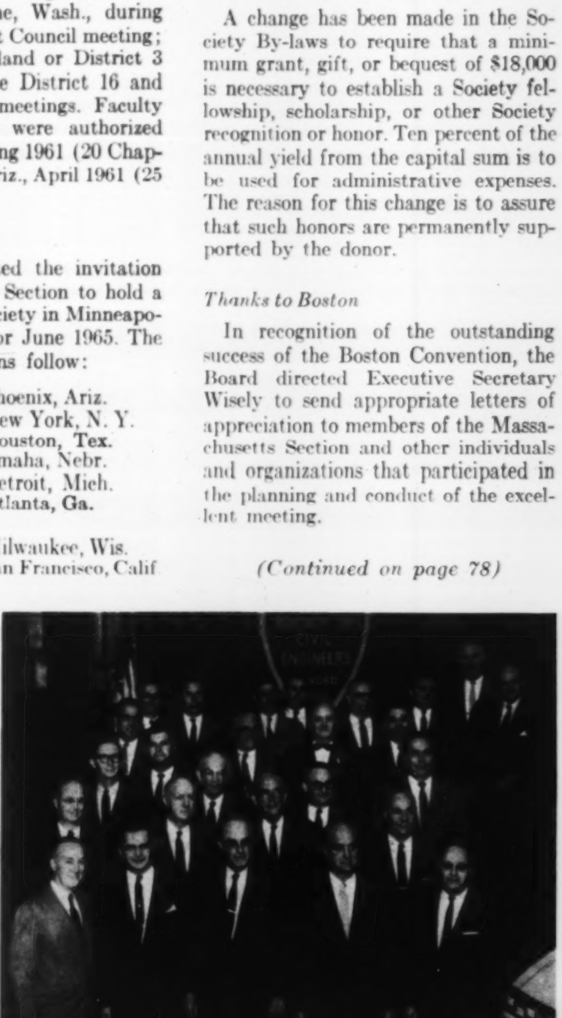
Fellowships and Honors

A change has been made in the Society By-laws to require that a minimum grant, gift, or bequest of $18,000 is necessary to establish a Society fellowship, scholarship, or other Society recognition or honor. Ten percent of the annual yield from the capital sum is to be used for administrative expenses. The reason for this change is to assure that such honors are permanently supported by the donor.

Thanks to Boston

In recognition of the outstanding success of the Boston Convention, the Board directed Executive Secretary Wisely to send appropriate letters of appreciation to members of the Massachusetts Section and other individuals and organizations that participated in the planning and conduct of the excellent meeting.

(Continued on page 78)



The new Board of Direction meets in Boston. Left to right, first row, are Vice Presidents Charles Molineaux, and William Hedley, President Glenn Holcomb, and Vice Presidents Lawrence Elsener and Donald Mattern; second row: Director Thomas Niles, Treasurer E. L. Chandler, Past President Frank Marston, and Executive Secretary W. H. Wisely; third (short) row: Directors Earl O'Brien, Bernhard Dornblatt, and Thomas Fratar; fourth row: Directors John D. Watson, W. W. Baker, D. B. Ventres, Earle T. Andrews and Roger Gilman. Fifth row: Directors Wayne O'Harra, Harmer Davis, C. W. Britzius, Elmer Timby, Trent R. Dames, and F. H. Rhodes, Jr. In back row are Directors Henry W. Buck, John B. Scalzi, and Samuel S. Baxter.

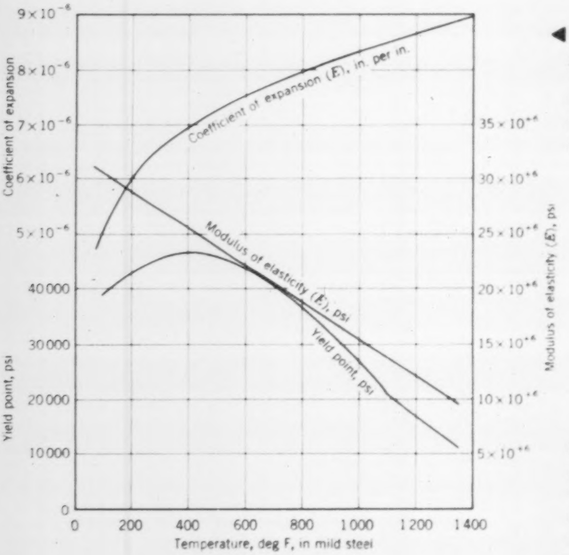
Shrinkage control in welding

OMER W. BLODGETT, F. ASCE, Design Consultant, The Lincoln Electric Company, Cleveland, Ohio

In making a weld, the heating and cooling cycle always causes shrinkage in both base metal and weld metal. Designers and engineers must anticipate and provide control of this shrinkage to achieve the full economies of arc-welded steel construction. Since the complexity of the problem makes it difficult to develop a purely theoretical solution, an attempt will be made here to integrate theory and practice in evaluating the causes of structural distortion. Suggested solutions for correction or elimination are based on theoretical analysis and on the practical experience of structural fabricating shops and erectors.

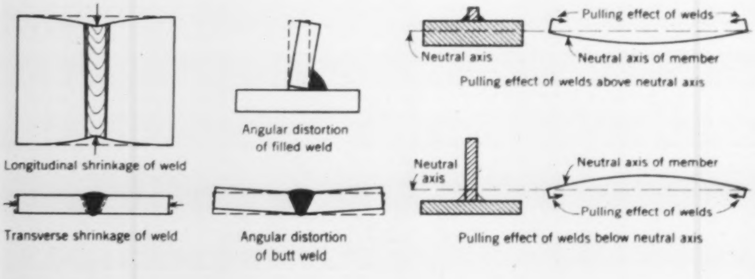
An analysis of distortion immediately points up the complexity of the problem. The arc area is the point of major concern. The enormous temperature differential, creating a non-uniform distribution of heat in the part, combined with the ability heat has to change the physical properties of the material, develops a difficult heat-flow problem. As the temperature increases, such properties as yield strength decrease, the modulus of elasticity decreases, the coefficient of thermal expansion increases, the thermal conductivity decreases, and the specific heat increases. See Fig. 1. To anticipate the movement of material from a straightforward analysis of heat is difficult.

Consideration of distortion must also include a mention of the effect of restraints. Here again the existing condition is not simple. Restraint from external clamping, internal restraint due to mass, and the stiffness of the steel plate itself must be considered. All these factors have a definite influence on the degree of movement.



◀ **FIG. 1. Properties of steel change with temperature and further complicate the theoretical analysis of weld shrinkage.**

FIG. 2. Distortion is a combination of the weld deposit causing shrinkage in various directions. ▼


Longitudinal shrinkage of weld
Transverse shrinkage of weld
Angular distortion of filled weld
Angular distortion of butt weld
Pulling effect of welds
Neutral axis
Neutral axis of member
Pulling effect of welds above neutral axis
Neutral axis
Neutral axis of member
Pulling effect of welds
Pulling effect of welds below neutral axis

Finally it is necessary to consider the factor of time as it affects the rapidly changing conditions. The period of time during which a specific condition is in effect controls the importance of that particular condition. These variable conditions are further influenced by the welding process itself. Different welding procedures, type and size of electrode, welding current, speed of travel, joint design, preheating and cooling rates—all these bear significantly on the problem.

It is obvious that distortion cannot be analyzed by viewing each one of these factors separately. A solution based on correcting the combined effect is the only practicable approach.

Evidences of distortion

When distortion is a factor, it appears as a shortening of the weld area. In most instances this can be cataloged as longitudinal shrinkage and transverse shrinkage. See Fig. 2. Furthermore, if transverse shrinkage is not uniform throughout the thickness of the weld, angular distortion will result. When longitudinal shrinkage acts in a direction that is not along the neutral axis of the member, the result is bowing or cambering, as also shown in Fig. 2. Structural fabrication may develop one or more of these conditions.

The cause of distortion

Distortion results when a condition of non-uniform expansion and contraction is created. Distortion can be anticipated by evaluating the following factors:

1. The weld along with some adjacent metal contracts on cooling, producing a shrinkage force, *F*.
2. The neutral axis of a structural member is the line about which the shrinkage force acts. The distance between the center of gravity of the weld area and this neutral axis represents the moment arm, *d*.
3. The moment of inertia of the section, *I*, resists this contraction. The *I* of a section not only reflects the resistance to distortion but also the resistance to straightening, should it be necessary.

Overwelding increases the shrinkage force, *F*, and the tendency to distort. Anything that reduces the amount of welding such as decreasing the leg size, reducing the weld length, or using intermittent welding techniques, will minimize this condition. Some of these techniques are illustrated in Fig. 3.

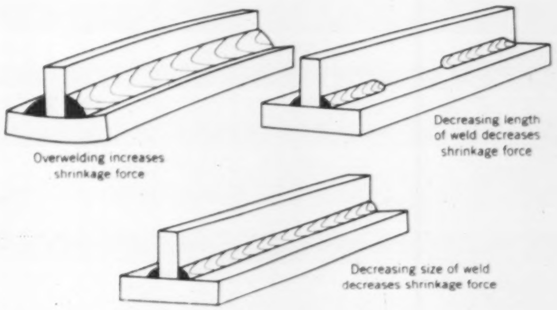

Overwelding increases shrinkage force
Decreasing length of weld decreases shrinkage force
Decreasing size of weld decreases shrinkage force

FIG. 3. Excessive distortion is frequently caused by overwelding.

Overwelding is useless and costly

Overwelding can be caused inadvertently by an unforeseen chain of events. The designer may specify the next larger size because of a lack of confidence in welding. When the part reaches the shop floor, the shop foreman, wishing to play it safe, marks the piece up for the next weld size. The welder, having just been criticized for making undersize welds, makes really sure that these welds are still larger. The result—a 1/4-in. fillet has become a 3/8-in. weld. In most instances these men do not realize that weld metal increases as the square of the size. The apparently harmless 1/8 in. of increase in the leg size has doubled the amount of weld metal deposited, thereby doubling the weld shrinkage and the weld cost.

Any resulting weld shrinkage must be controlled. One technique used to control weld shrinkage involves prebending the member or presetting the joint before welding. In this way the net effect of weld shrinkage pulls the member or connection back into proper alignment. See Fig. 4.

Wherever possible, welding should be balanced around the neutral axis of the member. This approach makes the moment arm, *d*, equal to zero. Even though a shrinkage force, *F*, does not exist, the net effect of the shrinkage moment ($d \times F$) is canceled out. Examples of this situation are shown in Fig. 5.

Another instance in which the amount of shrinkage force has been reduced is illustrated in Fig. 6. Here groove T-welds or fillet welds have been made with the submerged-arc automatic welding process. The deep penetration characteristics of this process lower the center of gravity of the weld deposit. If the neutral axis of the member is below this center of gravity of the welds, the moment arm is reduced, thereby reducing the shrinkage moment.

Adjacent base metal

Shrinkage of weld metal alone is not sufficient to account for the amount of shrinkage actually encountered. The heat of welding causes the metal just adjacent to the weld deposit to expand. However, this metal is restrained by the relatively cooler sections of the remainder of the plate. Almost all the volume expansion must take place in thickness. On cooling, the heated section will undergo volume contraction and build up shrinkage stresses in the longitudinal and transverse directions, and the adjacent base metal will tend to shrink along with the weld metal. This combined area produces the distortion.

Effect of high welding speeds

The volume of this adjacent base metal which contributes to the distortion can be controlled by welding procedures. Achieving higher welding speeds through the use of powdered-iron-type manual electrodes, semi-automatic and fully automatic submerged-arc welding equipment, or vapor-shielded automatic welding equipment reduces the amount of adjacent material that is affected by the heat of the arc and progressively decreases distortion.

The effect of welding current and arc speed on this adjacent base metal is illustrated in Fig. 7. The same weld size was produced with procedures (*a*) and (*c*). The important difference lies in the fact that the higher-speed welding technique produced a slightly narrower isotherm. If the width of this isotherm of 300 deg F could be used as an indication of the amount of weld plus adjacent metal shrinkage, and therefore distortion, it would help to explain why in general faster welding speeds result in less distortion. This slight difference is also evident in a comparison of the quantity of welding heat applied to the plate.

For (*a*),

$$\frac{EI\,60}{V} = \frac{(25\text{ v})\ (170\text{ amp})\ (60)}{3\text{ in. per min}}$$

$= 85{,}000$ Joules per lin in. of weld

For (*c*),

$$\frac{EI\,60}{V} = \frac{(35\text{ v})\ (310\text{ amp})\ (60)}{8\text{ in. per min}}$$

$= 81{,}000$ Joules per lin in. of weld

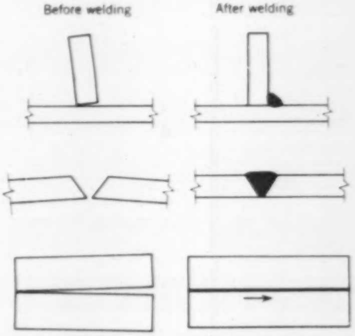


FIG. 4. Presetting is one technique for controlling weld shrinkage. Examples show presetting so that shrinkage will pull parts back into correct alignment.

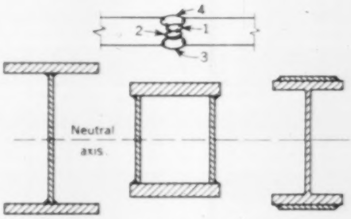
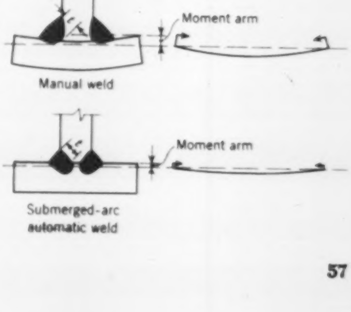


FIG. 5. By balancing the shrinkage forces through welding sequence and weld placement, final distortion can be reduced to zero.

FIG. 6. Use of deep penetration welding processes or procedures places the weld closer to the neutral axis of the assembly and reduces the moment arm and net effect of the shrinkage force.



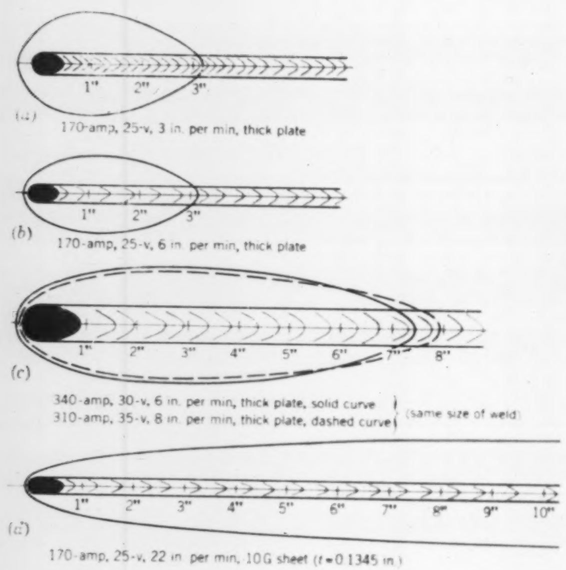
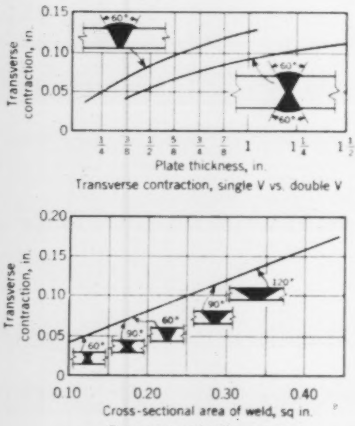
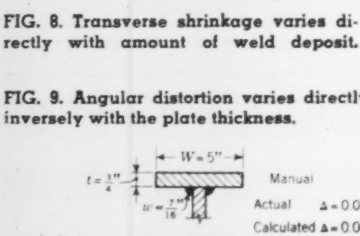

1"
2"
3"
(a)
170-amp, 25-v, 3 in. per min, thick plate
1"
2"
3"
(b)
170-amp, 25-v, 6 in. per min, thick plate
1"
2"
3"
4"
5"
6"
7"
8"
(c)
340-amp, 30-v, 6 in. per min, thick plate, solid curve
310-amp, 35-v, 8 in. per min, thick plate, dashed curve
(same size of weld)
1"
2"
3"
4"
5"
6"
7"
8"
9"
10"
(d)
170-amp, 25-v, 22 in. per min, 10G sheet (t = 0.1345 in.)

FIG. 7. Surface isotherm of 300 deg F is shown surrounding welding source.



Transverse contraction, single V vs. double V



Transverse contraction, constant plate thickness $\frac{7}{16}$" to $\frac{1}{2}$"

FIG. 8. Transverse shrinkage varies directly with amount of weld deposit.

Another condition can be observed by comparing conditions (*a*) and (*b*) of Fig. 7. In this instance, a weld of the same size was made with the same welding current but a different number of passes. The situation is similar to the production of a butt weld in the vertical up position, (*a*), as opposed to the production of the same joint in the horizontal position using a multiple-pass, stringer-bead technique. The faster welding of (*b*), 6 in. per min, produces a narrower isotherm. However, it requires two passes for every one of procedure (*a*), and the net result is an overall accumulative shrinkage effect greater than that for (*a*).

Shrinkage of a multiple-pass welded joint is analogous to the action of a car jack which rises an increment every time the handle is lifted. This helps to explain why a weld made with more passes will have greater distortion than one made with fewer passes. Application of this principle can be seen in techniques used to weld the single-bevel groove joint between a beam flange or top connecting plate and the side of the column in a beam-to-column connection. The transverse shrinkage can be reduced by using fewer passes. A further reduction could also be achieved by using larger electrodes.

It is to be noted that, in the weld on sheet metal, Fig. 7 (*d*), a greater portion of the adjacent weld metal is affected as compared to the weld itself. This, combined with the fact that the thinner sheet metal is less rigid than the thicker plate, helps to explain why sheet metal always presents more of a distortion problem.

Transverse shrinkage

Transverse shrinkage becomes an important factor where the net effect of individual weld shrinkage can be cumulative. An example of this is seen in a beam-to-column connection where a series of beam connections produce a transverse shrinkage force of sizable quantity as each individual increment is added along the entire length of the building.

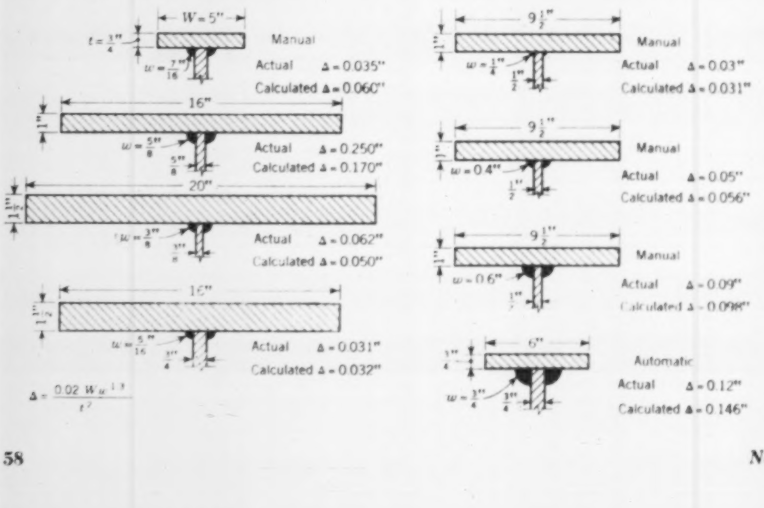
The charts in Fig. 8 throw some light on transverse shrinkage. In the lower chart transverse shrinkage, for a given plate thickness, is seen to vary directly with the cross-sectional area of the weld. The large included angles are used only to illustrate this relationship and do not represent common practice. The effects of single and double V-joints are seen in the upper chart. Both charts assume no unusual restraint of the plates against transverse movement. Calculations show that transverse shrinkage is about 10 percent of the average width of the cross-section of the weld area. Where the submerged arc process is involved, the cross-section of the fused part of the joint is considered rather than simply the area of the weld metal deposited.

Common practice for field welding of beams to columns usually finds the erector spreading the joint open before welding by an amount equal to what he expects it to contract after welding. Checking the column-to-column distance after welding provides a means of measuring weld shrinkages. This actual measurement then becomes a factor in controlling the opening of the next joint.

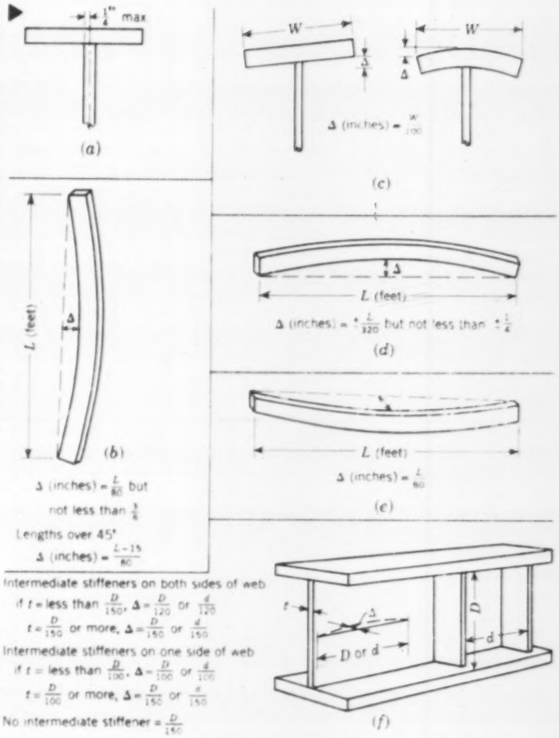
Angular distortion

The formula for calculating warpage is given at lower left in Fig. 9. Here are the actual and calculated warpage for each of eight different flanges, fillet

FIG. 9. Angular distortion varies directly with the flange width and weld size and inversely with the plate thickness.


W = 5"
t = 3/4"
w = 7/16"
Manual
Actual Δ = 0.035"
Calculated Δ = 0.060"
16"
1"
w = 5/8"
5/8"
Actual Δ = 0.250"
Calculated Δ = 0.170"
20"
1 1/2"
w = 3/8"
3/8"
Actual Δ = 0.062"
Calculated Δ = 0.050"
16"
1 1/2"
w = 5/16"
3/4"
Actual Δ = 0.031"
Calculated Δ = 0.032"
Δ = 0.02 W w^1.3 / t^2
9 1/2"
1"
w = 1/4"
1/2"
Manual
Actual Δ = 0.03"
Calculated Δ = 0.031"
9 1/2"
1"
w = 0.4"
1/2"
Manual
Actual Δ = 0.05"
Calculated Δ = 0.056"
9 1/2"
1"
w = 0.6"
1/2"
Manual
Actual Δ = 0.09"
Calculated Δ = 0.098"
6"
3/4"
w = 3/4"
3/4"
Automatic
Actual Δ = 0.12"
Calculated Δ = 0.146"

welded as indicated. The close agreement between the two values verifies the formula used. Only three exceed the American Welding Society allowable limit (1 percent of the width of the flange) as set forth in the Standard Specifications for Welding Highway and Railway Bridges (1956). It should be noted that these were overwelded. Permissible AWS tolerances for most welded members are illustrated in Fig. 10.



$\frac{1}{4}$" max
(a)
W
Δ
W
Δ
Δ (inches) = $\frac{W}{100}$
(c)
L (feet)
Δ
(b)
Δ (inches) = $\frac{L}{80}$ but
not less than $\frac{3}{8}$
Lengths over 45'
Δ (inches) = $\frac{L-15}{80}$
Δ
L (feet)
Δ (inches) = ± $\frac{L}{320}$ but not less than ± $\frac{1}{4}$
(d)
L (feet)
Δ (inches) = $\frac{L}{80}$
(e)
Intermediate stiffeners on both sides of web
if t = less than $\frac{D}{150}$, Δ = $\frac{D}{120}$ or $\frac{d}{120}$
t = $\frac{D}{150}$ or more, Δ = $\frac{D}{150}$ or $\frac{d}{150}$
Intermediate stiffeners on one side of web
if t = less than $\frac{D}{100}$, Δ = $\frac{D}{100}$ or $\frac{d}{100}$
t = $\frac{D}{100}$ or more, Δ = $\frac{D}{150}$ or $\frac{d}{150}$
No intermediate stiffener = $\frac{D}{150}$
t
Δ
D
d
D or d
(f)

FIG. 10. Permissible AWS tolerances for most welded members are shown: (a) deviation between center line of web and center line of flange; (b) camber or sweep of columns with lengths of 45 ft and under; (c) at left, tilt of flange, and at right, warpage of flange; (d) deviation of camber of girders; (e) sweep of girders; (f) deviation from flatness of girder web.

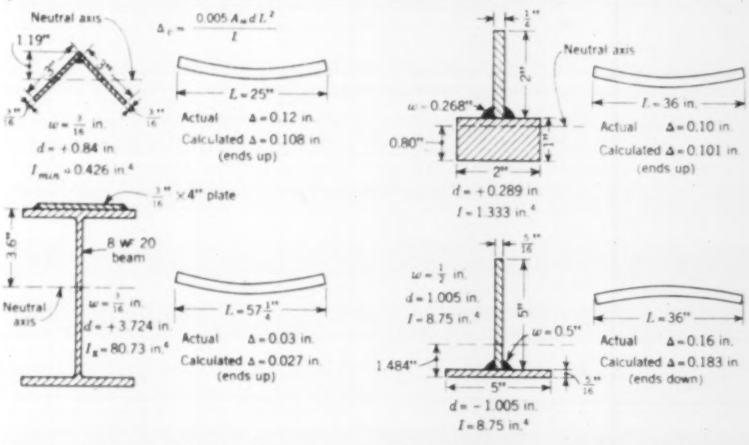
Bending of longitudinal members

Distortion or bending of longitudinal members results from the development of a shrinkage force applied at some distance from the neutral axis of the member. The amount of distortion is directly controlled by the magnitude of the shrinkage moment and the resistance of the member to the bending indicated by its moment of inertia.

Assuming no unusual initial stresses, the following formula, see Fig. 11, will indicate the amount of distortion or bending resulting from any longitudinal welding on a given member:

$$\Delta = 0.005\frac{A_w d L^2}{I}$$

A_w = total cross-sectional area within the fusion line, of all welds, (in.^{2})
d = distance between the center of gravity of the weld group and the neutral axis of the number (inches)
L = length of the member, assuming welding the full length (inches)
I = moment of inertia of the member (in.^{4})
= resulting vertical movement (inches)



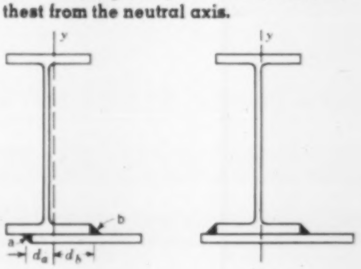
Neutral axis
1.19"
3"
3"
$\frac{3}{16}$"
$\frac{3}{16}$"
$w = \frac{3}{16}$ in.
$d = +0.84$ in
$I_{min} = 0.426$ in.^{4}
$\Delta_c = \frac{0.005 A_w d L^2}{I}$
$L = 25$"
Actual Δ = 0.12 in.
Calculated Δ = 0.108 in
(ends up)
$\frac{3}{16}$" × 4" plate
3.6"
8 W 20 beam
Neutral axis
$w = \frac{3}{16}$ in.
$d = +3.724$ in.
$I_x = 80.73$ in.^{4}
$L = 57\frac{1}{4}$"
Actual Δ = 0.03 in.
Calculated Δ = 0.027 in.
(ends up)
$\frac{1}{4}$"
2"
Neutral axis
$w = 0.268$"
0.80"
2"
2"
$d = +0.289$ in
$I = 1.333$ in.^{4}
$L = 36$ in.
Actual Δ = 0.10 in.
Calculated Δ = 0.101 in.
(ends up)
$\frac{5}{16}$"
$w = \frac{1}{2}$ in.
$d = 1.005$ in.
$I = 8.75$ in.^{4}
5"
$w = 0.5$"
1.484"
5"
$\frac{5}{16}$"
$d = -1.005$ in.
$I = 8.75$ in.^{4}
$L = 36$"
Actual Δ = 0.16 in.
Calculated Δ = 0.183 in
(ends down)

FIG. 11. Measurement of actual distortion verifies the formula for theoretical calculation of distortion.

When equal welds are placed on equal sides of the neutral axis of a member, a certain amount of distortion still occurs even though the magnitudes of the shrinkage moments are equal and opposite. It is believed that some plastic flow or upset in the compressive area next to the weld area occurs after the first weld is made. Because of this upset, the initial distortion, from the first weld, is not quite offset by the second weld on the opposite side. Where multiple-pass welding is involved, this condition can be corrected, as illustrated in the butt-weld procedure sequence, Fig. 5. Here Pass 1 is on the top side. Pass 2, deposited on the opposite side, will not quite pull the plates back into flat alignment; therefore Pass 3 is added to the same side. The net result will usually pull the plate slightly beyond the flat position and Pass 4, on the top side, should bring this plate back into flat alignment. Frequently this problem is of no major importance since the sections to be welded, plate girders, box girders, etc. are large enough in respect to the size of the weld to prevent the occurrence of this upsetting. As a result, on these large sections the second weld on the opposite side is just as effective as the first weld.

In cases where the welds are not symmetrically balanced about the neutral axis of the section, it may be possible to take advantage of this difference in distortion by first completing the joint nearest the neutral axis followed by welding the joint on the side farthest from the neutral axis. See Fig. 12. The two figures illustrate a masonry plate welded to the bottom flange of a rolled

FIG. 12. In cases where the welds are not symmetrically balanced about the neutral axis of the section, it may be possible to take advantage of this difference in distortion by first completing the joint nearest the neutral axis, and then welding the joint on the side farthest from the neutral axis.



y
y
b
a
d_a
d_b
y
y

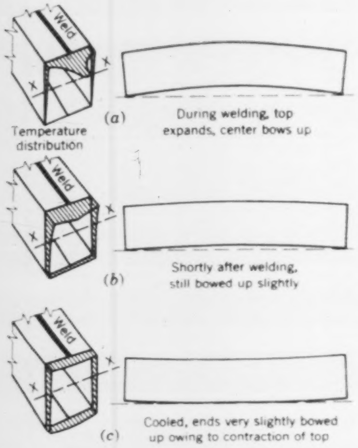

Weld
Temperature distribution
(a)
During welding, top expands, center bows up
Weld
(b)
Shortly after welding, still bowed up slightly
Weld
(c)
Cooled, ends very slightly bowed up owing to contraction of top

FIG. 13. Relatively long, thin box sections formed by welding two halves together require completion of the second weld before cooling of the first to avoid residual bowing.

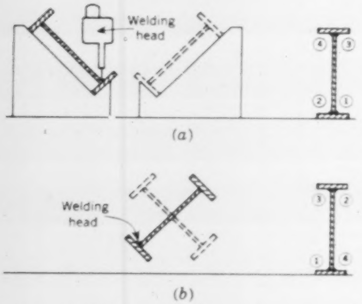


FIG. 14. Welding position and sequence are shown when girder is supported with an inclined fixture (a), or trunnion-type fixture (b). The member is turned by crane or on end trunnions.

beam. On the left, the welds are not symmetrical, so weld (*a*) was made first. Weld (*b*) follows since it has a greater moment arm. On the right, the wider masonry plate extends slightly on the left, and allows both welds to be made at the same time (since they are both in the flat position). The equal moment arms in this situation should result in no sweep of the beam. In both cases the welds will produce some camber but this is usually desirable.

Many long slender members such as light posts, sign posts, etc., are made by welding together two light-gage formed sections. Waiting until after the first weld has cooled before making the second weld on the opposite side will usually result in some final bowing since the second weld is not capable of pulling the member straight. Notice in Fig. 13 (*a*) that the heating of the top side of the member by the first weld initially causes some expansion and bowing upward. Turning the member over quickly while it is still in this shape and depositing the second weld will aid the pulling effect of this less effective weld deposit and the member will usually be straight after cooling to room temperature.

Attaching a cover plate to one flange of a rolled beam provides an example of unsymmetrical welding. Since the welds are on one side of the neutral axis, the beam will bow. In composite construction, this cover plate would be on the lower flange and the bending from welding would be in the direction in which camber is desired. Some fabricators try to estimate the camber resulting from the welding of the cover plate and will order the beam for the final required camber minus the camber they anticipate welding will produce. Most fabricators order straight beams from the mill, weld the cover plate, and then put the rest of the desired camber in by flame shrinking the flange to which the cover plate is attached.

Practical experience pays off during welding. A good setup man will provide temporary support for the beam at its ends to increase the camber from welding (assuming the beam is placed so that the cover plate is on top; i.e. the cover plate is narrower than the beam flange), or he will support the beam near its center and let the ends overhang to decrease camber from welding. By moving the supports in from the end of the beam or away from the center of the beam, he can decrease this correcting effect.

Welding sequence

The sequence for automatic welding to produce the four fillets on a fabricated plate girder can be varied without major effect on distortion. In most cases this sequence is based on the type of fixture used and the method of moving the girder from one welding position to another. When a single automatic welder is used, the girder is usually positioned at an angle between 30 and 45 deg, permitting the welds to be deposited in the flat position. This position is desirable since it makes welding easier and slightly faster. It also permits better control of bead shape and the production of larger welds when necessary, Fig. 14.

Proper alignment

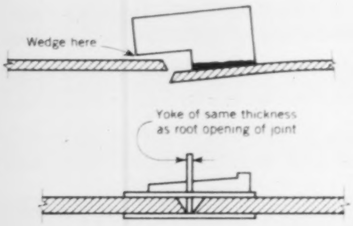
Various methods have been used for pulling plate edges into alignment and maintaining this alignment during welding. The most widely used technique is illustrated in Fig. 15. Small clips are welded to the edge of one plate. Driving a steel wedge between each clip and the second plate will bring both edges into alignment. Welding the clips on one side only simplifies removal.

In the top illustration of Fig. 16, pressure is being applied by steel wedges whereas in the bottom part of this figure, pressure is applied by tightening the strongbacks with bolts previously welded to the plate.

Peening

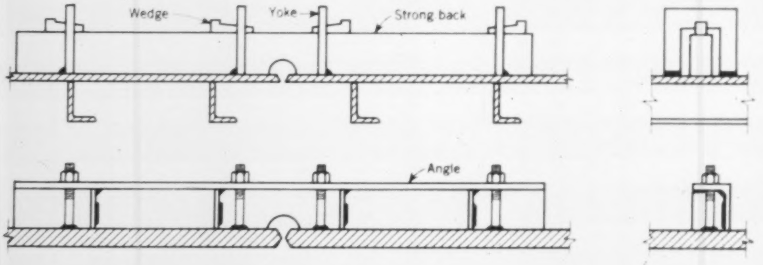
Peening is another method occasionally used to control distortion. Since the weld area contracts, peening, if properly applied, tends to expand it. However, this expansion occurs only near the surface.

Upsetting or expansion of the weld metal by peening is most effective at higher temperatures where the yield strength of the metal is rather low.



◀ **FIG. 15. Small clip angles and wedges provide an economical method for bringing two plates into alignment. Weld clip on one side only: it can then be knocked off by a blow of a hammer.**

FIG. 16. Wedges or bolts are used to pull plates into alignment on "strongbacks."
▼



Unfortunately, most distortion problems occur at the lower temperatures after the yield strength has been restored to its higher value. For this reason, peening does not accomplish the desired results. An additional disadvantage of peening is that it work-hardens the surface of the metal.

Flame shrinking

Flame shrinking or flame straightening is another method of correcting distortion. Correction is accomplished through localized heating with a torch. The heat causes the metal in the localized area to expand, and this expansion is restrained in all directions by the surrounding cooler metal. As a result, this area of the metal expands abnormally through its thickness and upon cooling tends to become shorter in all directions. The section so treated will become shorter with successive applications of heat. The bending of a member by welding and its straightening by flame shrinking is analogous to the case of a stool which will tilt to one side when the legs on one side are shortened but will again become erect when the opposite legs are also shortened the same amount.

Welding suggestions

1. Don't overweld.
2. Use minimum root opening and included angle.
3. Select a joint having minimum weld metal, for example a double V instead of a single V.
4. For a double V and similar joints, weld alternately on both sides for multipass welding.
5. Control fit-up.
6. Use automatic welding to take advantage of its deeper penetration as compared to manual welding.
7. Use a smaller leg size for fillet welds.
8. Use shorter welds, and intermittent welds instead of continuous if of the same leg size.
9. Where the same weld strength is desired, use longer and smaller leg fillet welds instead of correspondingly shorter and larger leg fillet welds.
10. Leg size of a fillet weld is important, since the area or amount of weld required increases as the square of the increased leg size.
11. Use iron-powdered electrodes instead of conventional electrodes.
12. Use faster welding speeds.
13. Deposit the greatest amount of weld metal in the shortest time.
14. Use welding positioners for the maximum amount of flat down-hand welding. This allows use of larger electrodes and automatic welding with faster welding speeds.
15. Balance welds about the neutral axis of the member, that is, have the welds opposite each other; this reduces the moment arm to zero.
16. Weld toward the unrestrained part of the member.
17. Weld first those joints that cause the most contraction.
18. Distribute the welding heat as evenly as possible.

Check to see if the following causes of distortion are present:

1. Residual stresses in sections due to rolling in the mill.
2. Buckling in a section due to improper handling or support.
3. Buckling from flame cutting or shearing.
4. Errors in original alignment.
5. Forcing of the joint, done to get a better fit-up.

Summary and check list

Transverse distortion:

1. Depends upon restraint.
2. Is equal to about 10 percent of the average width of the weld area.
3. Increases with the weld area for the same plate thickness.
4. Increases with the root opening and the included angle.
5. Is directly proportional to the welding heat input per inch, that is, Joules per inch.

Angular distortion can be reduced by:

1. Use of a double bevel, V, J, or U for butt welds.
2. Alternating welds from side to side.
3. Beveling the web of a T-joint; this will reduce the moment arm of the weld and reduce the angular movement.
4. Use of the smallest leg size for fillet welds, since the distortion varies approximately with the 1.3 power of the leg size of such a weld.
5. Use of thicker flanges; distortion varies approximately inversely with the square of the flange thickness.

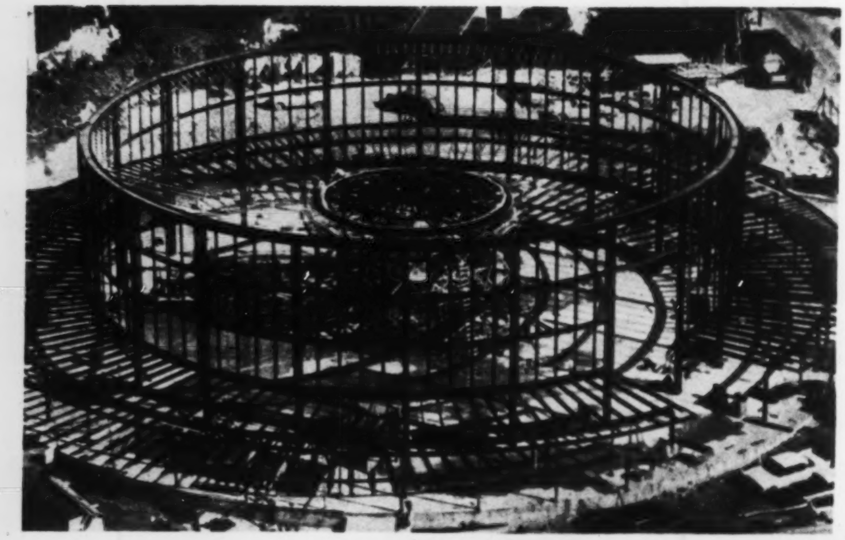
Bending of long members by longitudinal welds can be partially controlled by:

1. Balancing welds about the neutral axis of the member.
   a. Making welds of the same size at the same distance on the opposite side of the neutral axis of the member.
   b. For welds of different sizes—if at different distances from the neutral axis of the member—making the welds that are further away smaller.
2. If the welding is not symmetrical, this result is achieved by:
   a. Prebending the member.
   b. Supporting the member in the middle and letting the ends sag, and for the opposite effect, by supporting the member at the ends and letting the middle sag.
   c. Breaking the member into subassemblies so that each part is welded about its own neutral axis.

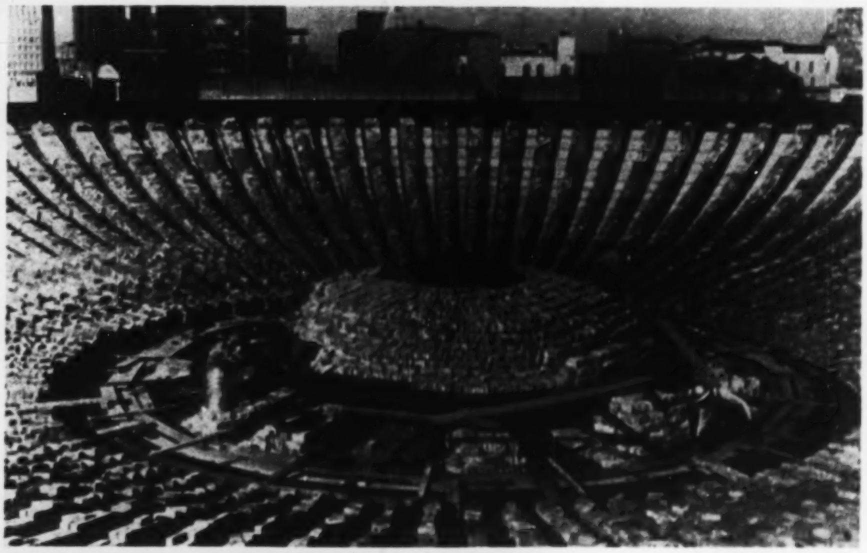
Deflection is directly proportional to the shrinkage moment of the welds (weld area times its distance from the neutral axis of the member) and inversely proportional to the moment of inertia of the member. Although a high moment of inertia for the member is desired to resist bending, it also makes the member more difficult to straighten, once it has become distorted. Flame shrinking may be applied to the longer side if welding has bent the member by shrinking one side.

Assembly procedures that help control distortion:

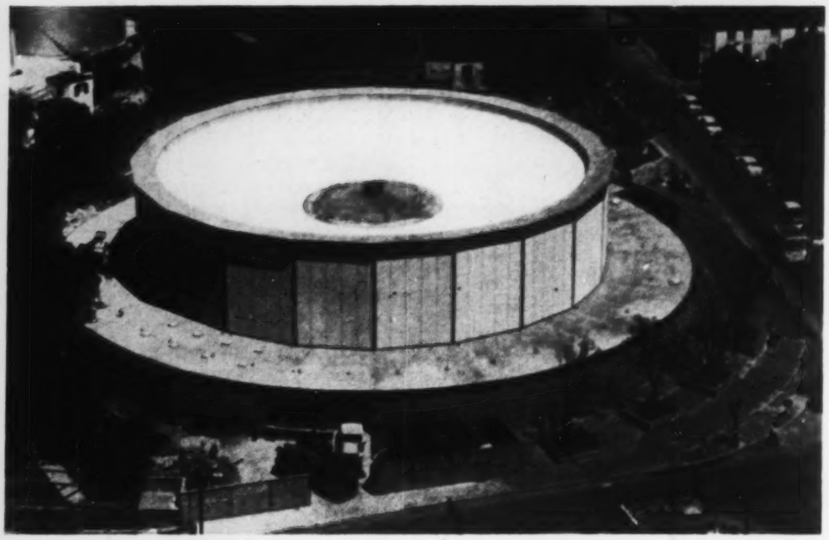
1. Clamp the member in position and hold during welding.
2. Preset the joint to offset expected contraction.
3. Prebend the member to offset expected distortion.
4. Weld two similar members back to back with some prebending.
5. If needed to stress relieve, weld two similar members back to back straight and keep fastened until after stress relief.
6. Use strong-backs.
7. Use jigs and fixtures to maintain proper fit-up and alignment during welding.
8. Make allowances for contraction when a joint is assembled.
9. Arrange the erection, fitting, and welding of the parts so that they will have freedom to move in one or more directions as long as possible.
10. Use subassemblies and complete the welding in each before final assembly and welding together.
11. Break the member into proper sections, so that the welding of each section is balanced about its own neutral axis.
12. Weld the more flexible sections together first, so that they can be easily straightened before final assembly.



Steel frame is completed for Villita Assembly Building in San Antonio Tex. Center ring and 200 cables are in place for the roof system. The center ring is seen still in place on the tower used during erection.



Suspended cable roof system was preloaded using 230,000 bricks. Slots between the individual precast concrete roof slabs were to be filled with concrete and bricks were so placed as to provide access to the slots.



Completed assembly building, resembling a large hat, provides column-free interior.

Cable-suspended roof for San Antonio Assembly Building

W. E. SIMPSON, F. ASCE, Consulting Engineer, San Antonio, Tex.

A circular steel frame with a saucer-shaped cable-suspended roof—using a blend of the old and the new in a shape resembling a large hat—this was the architect's answer to the problem he faced in designing the Villita Assembly Building in San Antonio, Tex.

When the City Public Service Board decided to construct an assembly building on a site adjacent to the city's historic Alamo-era settlement, La Villita, it raised the problem of how to erect a modern building that would harmonize with the Mexican architectural atmosphere.

One of the requirements was a column-free interior. The architect selected the circular shape to fulfill this requirement and to obtain maximum utilization of the tract. A domed roof was ruled out because it was felt that it would dwarf the low buildings in La Villita. The idea of a cable-suspended roof system was then studied and found to be economically feasible. At the time this building was designed, there was only one other structure of this type in existence, in Montevideo, Uruguay. (See M. Schupack's article, CIVIL ENGINEERING, April 1958, vol. p. 248.) The building in San Antonio was the first cable-suspended circular-roof structure in the United States.

The interior clear-span is 132 ft, with the columns located on the 132-ft-diameter line. There are twenty columns on the circumference, equally spaced a little over 20 ft apart.

Columns carry steel T-beam

Resting on top of the columns is a built-up T-beam of steel. Its vertical stem is a 16-in. WF 64, designed to carry all the vertical loads. It was curved to the 132-ft diameter. The horizontal top of the "T," designed to carry all the horizontal pulls from the cables, is a welded plate-girder made up of a 23-in. x ½-in. web plate, cut to the proper curvature, two flange plates 9 x ½ in., and four angles, 4 x 4 x ⅜ in. The length of each section of T-beam is the distance between the columns. All splices and connections were welded. The required beam splice was not located over a column, but at a point 3 ft from the column.

To this perimetric T-beam, 200 steel cables were fastened at approximately 2-ft intervals, attached through turnbuckles to gusset plates welded into both the horizontal and the vertical beams. The turnbuckles were used to provide for cable adjustment. These Bethanized 19-strand high-strength cables are 11/16 in. in diameter.

Cables attached to "spider"

To provide for the attachment of the cables in the center of the roof system, a steel "spider" was used. This consists primarily of a vertical plate 1½ in. x 14 in., curved in sections to its 40-ft diameter, and butt welded. Twenty steel trusses radiate out from a center drum or hub in this 40-ft span. The cables are attached directly to the gusset plates welded to the rim plate of this unit.

The cable fittings were pressed swaged at each end. Each cable has a total length of 47 ft 3 13/16 in.

To avoid continued stretching of the cables due to tightening of the strands after erection, the cables were all prestretched by being loaded to one-half of their ultimate strength and held there for 15 minutes. This operation was repeated a second time. The stretching load used was 25,500 lb.

To make sure that the swaging of the cables to their connections was efficient, two of the cables were test stretched to failure. In each case the cable broke while its swaged connections remained in perfect condition. The loads applied to these cables were 58,000 lb and 57,583 lb.

The roof deck, attached to the cables, consists of 4,000 lightweight precast concrete-slab units, arranged in 20 concentric rows, approximately 2 ft in width, with 200 slabs to the row. All slab units in each concentric row were cast alike. The slab widths taper from approximately 2 ft for those in the outer row to about 7 in. for those in the inner row, following the converging angles of the cables. Steel hooks were cast in the slabs to provide attachment to the cables.

In placing the concrete slabs, a 2½-in. space was allowed between the slabs along the radial lines which contain the cables and a 2½-in. space between the concentric rows. After all the roof-slab units were in place, the cables were prestressed to place the concrete deck in compression. This was accomplished by the use of some 230,000 bricks placed so as to load the whole roof with a load of 50 lb per sq ft more than all the dead and live loads calculated.

This loading stretched the cables some ¾ in. while the concrete was being poured in the slots between the slabs along the cables, and in the concentric-circle slots between the slabs. A concrete fill was also poured over the entire roof area. After the concrete was placed, the extra applied load was removed, leaving the concrete in compression because of the residual tension in the cables. The roof system therefore acts as a stiffened dome-like slab and will not be subject to excessive vibrations or bounce. A built-up roof was placed over the concrete fill.

As the saucer-shaped roof can collect appreciable quantities of water, an adequate drainage system is a necessity. Twenty 5-in. roof drains around the perimeter of the central spider unit are connected to a 6-in. pipe and then to the 8-in. and 12-in. downspouts which carry the water to the exterior wall, and so out to the street level. Seven of the outlets will actually take care of the heaviest rain that has ever been recorded in San Antonio, which is 2½ in. in 15 min. A rainfall of this intensity has occurred in San Antonio about every five years.

The total cost of the building, including air conditioning, was about $953,800.

O'Neil Ford & Associates were the architects. G. W. Mitchell was the general contractor, and W. E. Simpson Company the structural engineers. The structural-steel frame was fabricated by the Alamo Iron Works. All are of San Antonio, Tex.

Why negotiate for photogrammetric services?

A. O. QUINN, F. ASCE, Chief Engineer, Aero Service Corporation, Philadelphia, Pa.

To secure photogrammetric mapping services from firms specializing in this work, state highway departments are now beginning to rely on negotiation as opposed to competitive bidding on the basis of price alone. Negotiation offers many advantages, which provide opportunities for securing a better job at the same or a lower price. As a representative of the professional photogrammetric engineers who serve the civil engineering profession, I would like to discuss a few of these advantages.

First, negotiation offers the inherent advantages of consultation, which can never be realized under competitive price bidding. One of the primary reasons for seeking the services of an outside consultant at the beginning of a project is the hope that he can bring something to the assignment which the staff cannot. This point has been made repeatedly by administrators of departments and agencies with competent engineering staffs of their own. They seek an outside consultant who can offer them a fresh or a different outlook, because he has accumulated a broader experience, because he has served a variety of clients and encountered a far greater variety of photogrammetric mapping problems in the field and in the laboratory than the average client, and because in this age of specialization, he keeps abreast of new methods and equipment in the rapidly growing field of photogrammetry through continuous research and development programs.

Bidding kills initiative

Under competitive bidding for photogrammetric engineering services, it is impossible to reap the advantages of this service—which is indeed the most important service the consultant can offer. Under competitive bidding, the consultant is asked to submit a bid for a specific project, to be accomplished in a specific, predetermined way. Thus the consultant is not required to bring a fresh or a different outlook to the assignment. He is not asked to employ his experience to suggest a better and more economical way of doing the job. He is required to accomplish the work in the specified way—the way the client has already decided he wants it done. This is as wasteful as telling a missile expert not only what to produce to probe the unknown frontiers of space, but also how to conduct his laboratory experiments.

If the photogrammetric consulting engineer is obliged to follow client-developed specifications—which are necessary under competitive bidding to obtain uniform bids—he is not required to bring to the assignment any new knowledge or any advanced methodology. He may—but it is not demanded of him.

Too much emphasis cannot be placed on this point. The next ten years will see a very rapid obsolescence of current methods and existing equipment employed in surveying and mapping. Any state highway department or other agency that leans too heavily on standard specifications will deny itself the benefits of improved techniques and equipment. These could provide higher quality or lower cost or both. We frequently find that a client asks for either more or less basic data than he will actually need on his surveys or maps. In many cases, we can help him to save a considerable amount of time and money by providing surveys and maps that are tailored to suit his particular requirements.

The second advantage concerns the matter of long-range cost. The competitive bidding procedure forces the client to obtain mapping services on the basis of "first cost only." Some government agencies feel they must request bids for surveying and mapping services in order to conserve public money. However, saving on the first cost of surveying is not usually a way to save on the total cost of a project.

Engineers are painfully aware of the dangers of opening the gate to a flood of low bids from inexperienced firms, incapable of completing the assignment at the price submitted. As is well known, the expense of extensive field checking and rechecking of mapping work is high in relation to the first cost. Such checking is time consuming and delays the project.

In surveying and mapping, as in other engineering functions, a minimum job completed with minimum effort to meet a minimum price can produce a chain of minor irregularities that lead to higher construction costs. This is particularly true in the highway field, where location engineers and designers are relying increasingly on photogrammetric mapping. The cost of contour maps or cross sections is a very small percentage of the cost of construction. Yet, if these are inaccurately plotted, they may result in very high and unnecessary earth-moving costs.

These are things that staff engineers in the department usually understand. But they have to be explained to management, which is generally concerned with first costs.

A few months ago at the 1960 meeting of the American Society of Photogrammetry, Brother B. Austin Barry, M. ASCE, Associate Professor of Civil Engineering at Manhattan College, New York, N.Y., and Chairman of the ASCE Task Committee on the Status of Surveying and Mapping, said: "Topographic surveying and mapping cannot be subject to the whims of a low budget dictated by prevailing market conditions.

Give the engineer a chance

"The engineer executing the survey and preparing such a map must have the independence to exercise judgment to spend enough to do the right job. Hence the form of contract must be one that guarantees this independence—and it cannot be based on the lowest price."

This observation comes from an engineer who is not engaged in the private practice of mapping. He knows from intensive study and a continuing observation of this profession that the fullest technical advantages of photogrammetry cannot be realized if these services are produced under bargain-basement conditions.

A third important point is that surveying and mapping by photogrammetric methods have been declared to be a part of the civil engineering profession by action of the Board of Direction of the American Society of Civil Engineers. (See Civil Engineering, May 1959, p. 74). This action was taken because all the arguments for professionalism of civil engineers were found to apply to photogrammetric engineers or photogrammetrists, including those that dictate the methods under which private engineers shall do business. These are sound arguments; they have stood the test of experience; they have raised the status of the engineering profession generally. The same results may be expected as photogrammetrists are required to carry on their business along professional lines.

Other advantages of negotiation for photogrammetric contracts are given by J. S. Piltz, of the Wisconsin State Highway Department, in his article, "How to Negotiate for Photogrammetric Mapping Services" (Civil Engineering, July, 1960, p. 68).

Negotiation is not a new course of action for many photogrammetric engineering firms. Most are experienced in negotiating the needs and terms of various types of assignments, and many are already staffed by engineers who have considerable civil engineering experience and are licensed to practice as professional engineers.

Most client agencies will find it simple to adopt the method of negotiation instead of seeking competitive bids for their surveying and mapping work. Traditionally, a number of state highway departments, federal government agencies, and other organizations have negotiated for such work. They have found the professional way advantageous.

Even for those who have not previously negotiated such work, the ASCE policy decision is not posing an unsolvable problem. The status of civil engineering as a profession, including the methods under which professional consultants are retained, is well established and well respected. A few chief engineers may be obliged to explain to management why photogrammetric engineering has been classified as professional and what the practical effects of this ASCE policy decision will be. There is no reason to doubt that their recommendations will be received with respect and confidence.

Meanwhile, the exchange of constructive ideas will make the transition easier for all concerned. Time will confirm the wisdom of this course of action, which the ASCE recommended after more than four years of thorough study and in which photogrammetrists concurred only after the most thoughtful consideration.

Dr. James Killian a Convention luncheon speaker

■ FEATURED SPEAKER at the awards luncheon during the Society's Annual Convention in Boston was Dr. James R. Killian, Jr., chairman of the Massachussetts Institute of Technology Corporation. Drawing on his experience, which includes several years as Special Assistant to the President for Science and Technology, Dr. Killian discussed five areas of increasing responsibility for the engineer: "(1) The role of the engineer in helping to make the policy decisions for such vast technological efforts as our space program; (2) the urgent problems inherent in improving our living environment; (3) the need for the engineer in government; (4) the responsibility of the engineering profession to strengthen itself through research; and (5) the need to strengthen and invigorate engineering education.

"Since World War II the status-seekers in the community of nations have relied increasingly on science and engineering to build their prestige. The Soviets especially have used technology as an instrument of propaganda and power politics, as illustrated by their great and successful efforts—and careful political timing—in space exploration. . . .

"Spectacular accomplishments in space technology have enhanced the prestige of the Soviet Union," said Dr. Killian, "and we can all admire their achievements. But their expensive emphasis on space exploration will not be enough in the long pull to sustain an image of strength. This will only be accomplished by a balanced effort in science and technology. True strength and lasting prestige will come from the richness, variety, and depth of a nation's total program and from an outpouring of great discoveries and creative accomplishments on a wide front by its scientists and engineers. . . .

"We must never be content to be second best, but I do not believe that this requires us to engage in a prestige race with the Soviets. We should pursue our own objectives in space science and exploration and not let the Soviets choose them for us by our copying what they do. We should insist on a space program that is in balance with our other vital endeavors in science and technology and that does not rob them because they currently are less spectacular. In the long run we can weaken our science and engineering and lower our international prestige by frantically indulging in unnecessary competition and prestige-motivated projects.

"The engineers of the nation have a responsibility to bring their special insight and knowledge to bear in assisting the clarification of public policy in these matters and to resist the misuse of technology. Their responsibility extends beyond the mere exercise of their specialized technical competence; they must participate in the broader responsibilities of shaping sound public policy.

"This strategic role of the civil engineer in the control of our physical environment puts him in the front line in the fight to combat urban decay and to reduce and eliminate the growing pollution of our streams and our air. He needs a sensitive understanding of the importance of conservation, of the preservation of wildlife, of the importance of enhancing and protecting the national beauty of our land, and of the importance of good taste in determining the characteristics of a good environment. Unless our engineers have this sensitivity and responsibility for maintaining and enhancing the quality of our environment as well as its material advantages, the great public works they build today will yield far less benefit to our people.

"Every profession and every individual has a responsibility to combat ugliness and deterioration, but I venture to suggest that our civil engineers, by working closely with our city planners and our architects, are in a key position to mobilize the forces required to achieve a new level of humaneness and benignity in our environment. Ugly engineering structures, however practical, may in the long run be an economic waste."

Concerning research Dr. Killian said, "More than any other branch of engineering, civil engineering needs to strengthen its foundations through research. . . . especially . . . that kind of research which will generate the civil engineering of the future."

Bottom of San Francisco Bay evaluated for Trans-Bay Tube

R. J. SWAIN, Chief, Structural Seismology, United ElectroDynamics, Inc., Pasadena, Calif.

Survey reveals elastic and structural properties of bay-bottom materials. Unique instrumentation was employed to sense and record earthquake data for use in designing a quake-proof tunnel.

A new tunnel 30 ft in diameter under San Francisco Bay will link San Francisco to Oakland, Calif., in the mid 60's. Up to 40,000 people per hour will traverse the tunnel in each direction, in electrified rapid-transit trains—immune to earthquake hazards. Construction will begin after a study and evaluation program is completed.

The purpose of the survey was twofold. Phase 1 revealed the in situ elastic and structural properties of the various layers of bay-bottom materials that are to support the tube. Phase 2 involved the design, development, fabrication and installation of a unique earthquake sensing and recording system, the prime purpose of which is to determine the relative amplitudes of ground motion induced at various depths. The recording system may be used to make dynamic measurements after the tube is installed. It will be very useful in studying traffic effects as well as the actual response of the tube to earthquakes as they occur.

Survey of elastic constants

In Phase 1 of the contract, elastic constants were computed, and plots and curves of data obtained during the survey were prepared. Determinations were made of shear wave velocity, compressional wave velocity, and density of the materials under test. From these data, seismologists computed Poisson's ratio, the bulk modulus, rigidity modulus, and Young's modulus, which reveal the in situ properties of each layer.

Certain difficulties were anticipated in determining the elastic constants. Since water neither supports nor propagates shear waves, it was believed impossible to make determinations in the very soft upper extremities of the bay mud. One of the most significant findings of the survey was that the "bay mud" was not nearly as soft as had been expected; it propagated the shear waves without appreciable attenuation.

The survey of elastic constants involved the following procedures. Working from a barge in San Francisco Bay, four holes were drilled down to the underlying shale, and cased with plastic casing. Since the seismic-velocity characteristics of the plastic casing closely approximate those of water, the use of casing did not introduce errors into the results. The casing was set all the way from the shale substructure to several feet above the water surface at high tide. The holes were located 40 ft apart along the orientation line of the tube crossing.

After the first three holes had been drilled and cased, drilling and casing of a fourth hole began. During this operation, shear-wave velocity measurements were made, using a special shear-wave generator developed by United ElectroDynamics. The fourth hole was jetted and cased in ten steps from the surface of the mud down to the shale interface. At each interval, jetting was suspended, and by the use of the special generator, shear waves were initiated. The velocity of these waves was determined by recording the time of arrival of the shear waves in the three adjacent holes. Arrival times were sensed by special geophone assemblies placed in the three holes at the same depth as that of the shear-wave generator in the fourth hole.

This step-by-step procedure was continued until the fourth hole had been drilled and cased to the shale interface, at which point a final measurement was made to determine the shear-wave velocity in the shale.

Next, the dilatational or pressure-wave velocity measurements were made. Beginning at the bottom of the fourth hole, small dynamite charges were detonated at ten intervals, moving from the shale interface up to the surface of the mud. Each time the geophone assemblies in the three adjacent holes were moved so that they would be at the same level as the detonation. Concurrently several waterproof geophone assemblies, placed at the surface of the mud, sensed the uphole velocities for purposes of cross correlation.

From the information obtained in this way, and density information previously supplied, the elastic constants and Poisson's ratio were computed. As is the case in most other structural surveys performed by United ElectroDynamics, the velocities and elastic constants differ considerably from conventional laboratory determinations. In most instances the values obtained are much higher. There exists little doubt among most soils and foundation engineers that the in situ seismic values are the more accurate.

Earthquake sensing system

As Phase 2 of the program, an earthquake sensing and recording system was designed, built, and placed in operation. Recordings may continue for two years or more, until sufficient information is accumulated on which to base earthquake-proof design and construction of the tunnel.

The earthquake-sensing system consists of three geophone assemblies, and the cables necessary to bring the geophone signals from the bay bottom to Pier W-5 of the San Francisco-Oakland Bay Bridge. Geophone assemblies are placed at three elevations in the bay bottom. Each assembly consists of six geophones and two level-sensing devices.

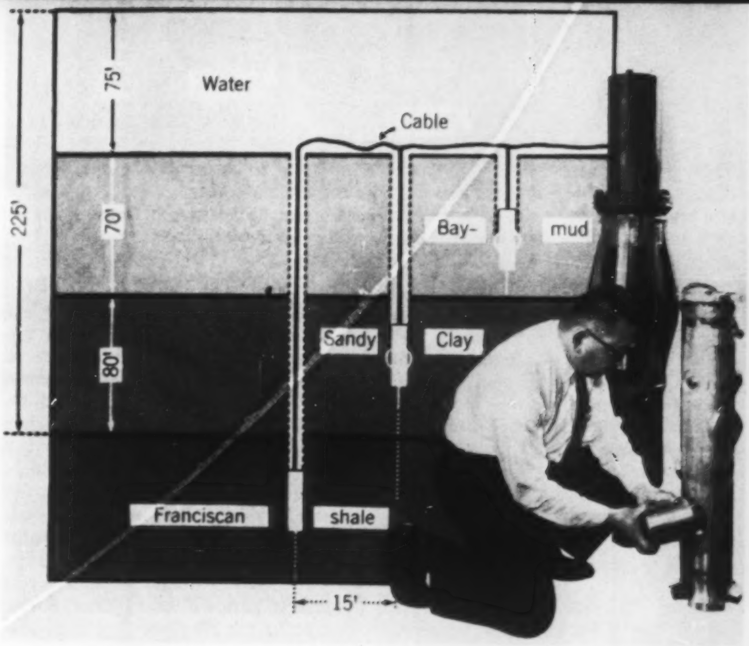
Three holes were drilled, each located at some distance from the holes for the elastic-constant survey, because of the probable disturbance of the bay bottom during pressure-wave velocity determinations. The holes were lined with a steel casing, which was withdrawn after the geophones were located.

The mass suspensions of low-frequency seismometers are extremely sensitive to leveling. Hence almost all seismic transducers in the frequency-pass band of interest in the San Francisco Bay study provide mechanical means for level adjustment. Horizontal seismometers are more sensitive than the vertical models at the same natural frequency. For the case in point, with six degrees of tilt from vertical the mass rests on the stop.

Any means of leveling the geophone assemblies had to be remote because any electro-mechanical means would have greatly complicated the instrument packages. It was decided, therefore, that the best compromise was to concentrate on near-vertical placement and to fall back on electrical mass centering if the actual tilt angles were too great. Under the conditions found on a barge, laboratory accuracies are not simple to attain, particularly at the end of a 225-ft drill stem.

When the installation was completed, measurements were made which showed that none of the geophone assemblies was more than 1.24 deg from the vertical, and that in three of the six planes checked (two for each assembly) the tilt was less than ±0.1 deg. Therefore electrical centering was not required.

Two geophone assemblies were equipped with long points on their lower ends so that they could be forced into sand-clay and mud. The third geophone, placed in shale, had a group of heavy springs around its periphery to provide for a positive attachment to the shale structure. In all cases, the geophones were gently forced into place with a heavy drill collar, by means of a special tool designed by United ElectroDynamics. In removing each casing, exceptional care was exercised to avoid injury to the cable, which ran down through the casing to the geophone assembly. Each assembly was grouted in place with fine gravel.



Engineer at right is installing one of six geophones in earthquake-sensing assembly which will be placed inside watertight housing behind. Assembly is then buried in drill hole in bay bottom as shown in typical cross-section.

Cable arrangements

Three short cables were used to connect the geophone assemblies to a 2,500-ft main cable, which in turn was tied into the telephone company's intercity lines at Pier W-5 of the Bay Bridge. At each end cables are fitted with special underwater connectors. Seismic signals are carried over the telephone lines to 101 California Street, in San Francisco. Here they are filtered, amplified, and continuously recorded on paper.

Earthquake recording system

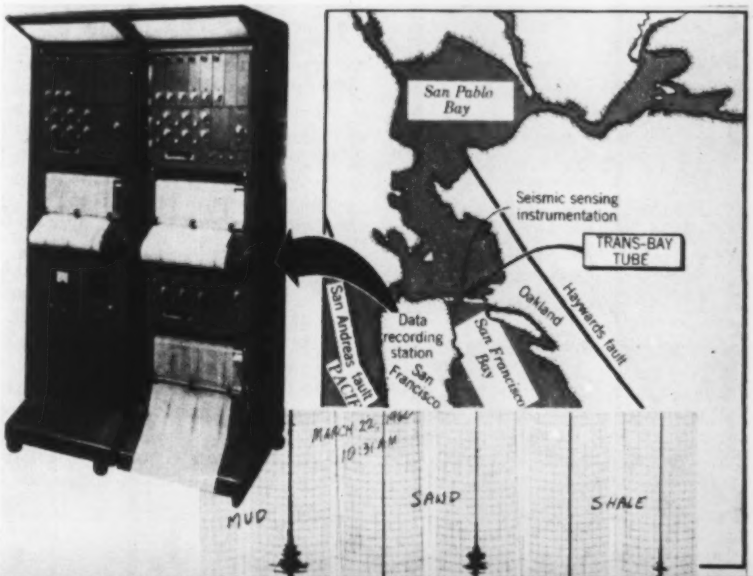
To cover the range of earthquake magnitudes that can occur, a dual-trace readout system is used. This system can handle quakes larger than any ever recorded, and provides information on minute tremors as well. As a matter of fact, the sensitivity of the system will be purposely reduced so that it will not record such things as ship movements and traffic on the Bay Bridge. The system includes triggering circuitry, which speeds up the recording paper at the beginning of each tremor, to conserve the miles of recording paper that would otherwise be used. If it were not for this feature, the system would require more than $10,000 worth of recording paper each year.

Incoming signals flow through a control test panel that switches and selects signals, and carries out functional requirements for calibration and performance checks. For maximum accuracy in recording, signal outputs from the earthquake geophones have been compared with recordings obtained on a Wood-Anderson seismograph—a standard in the field. This work was done at the Cal Tech Seismological Laboratory in Pasadena, close to the headquarters of United ElectroDynamics. Additional comparisons are being made in San Francisco.

Actually, three complete recording systems are provided, each containing the components necessary to read out six traces simultaneously. Thus, 18 traces of earthquake data are being recorded. This arrangement makes it possible for the east-west horizontal geophones in each of the three layers to be recorded side by side for direct amplitude and frequency comparison.

The study and instrumentation contract has been awarded to United ElectroDynamics, Inc. of Pasadena, California, a firm that is working in cooperation with its affiliate, the United Geophysical Corporation. Serving as consultants on the program are Dr. George Housner, M. ASCE, seismologist and noted earthquake engineer, of the California Institute of Technology, and Dr. Frank Press, Director of Cal Tech's Seismological Laboratory and a member of the Board of Directors of United ElectroDynamics, Inc.

Map of San Francisco Bay area shows proposed location of Trans-Bay Tube in relation to Bay Bridge. Recording station at 101 California Street in San Francisco, at left, continuously monitors seismic signals conducted over four miles of telephone lines from geophone assemblies installed in vicinity of bridge.



STEEL PIPE COATING SYMPOSIUM

A discussion of • PLASTIC TAPE • ASPHALT • CEMENT MORTAR • SOMASTIC • COAL TAR

1. Plastic tape

W. J. McCAY, Barnes & Delaney Company (agents for the Kendall Company, Polyken Sales Division), Long Beach, Calif.

In the past ten or fifteen years, pressure-sensitive plastic tapes have taken their place alongside conventional hot applied materials as an overall external pipeline coating. In the early 1940's, exploratory research was begun on synthetic resins for electrical insulation. This research led to the development of the now familiar electrical tapes which are used for nearly all primary electrical splicing in high-voltage and high-frequency installations. This effort was extended to the field of corrosion control, where parallel insulating properties are needed for the interruption of the electrochemical processes that produce corrosion.

Cold-applied, pressure-sensitive plastic tape can be broken down into its two component parts—plastic backing material and adhesive. The backing material is either polyvinyl chloride or polyethelene and the thickness varies from 8 to 10 mils, depending on the manufacturer. The adhesive, which is applied at the factory and which performs the bonding function, is a blend of synthetic and natural rubbers and varies in thickness from 1.5 to 4 mils, again depending on the manufacturer. Both the plastic backing and the adhesive are stabilized against aging for an indefinite period of time, either in storage or in the field under normal conditions.

As with other types of coatings, surface preparation for tape coatings is important. It is not necessary that the pipe be sandblasted to bright metal, but it is necessary that material which would have a tendency to neutralize the adhesive, such as loose rust, dirt, dust, oil, grease and moisture be removed. Wire brushing will normally remove any loose material, and wiping with a totally volatile solvent is sufficient for removing oil and grease.

The ease with which tapes can be applied has certainly been a major factor in hastening their acceptance. Simple one-coat application right from the roll at high speeds, either by hand or by machine, makes tapes economical to use on all cylindrical surfaces in practically all situations. Temperature, humidity, wind velocity and other uncontrollable environmental conditions have no effect on such characteristics as coating thickness, pin-hole content, bond, drying or setting rate, sagging properties and endless other factors,

2. Asphalt

D. J. McNUTT, Douglas Oil Company of California, Los Angeles

Asphalt protective coatings are manufactured from specially treated petroleum products that are thoroughly tested and engineered for the particular protection job at hand. The user may be assured that the quality from batch to batch has been tested against the specifications and found to be uniform, thus assuring continuously successful yard or field application.

Generally speaking, asphalt coatings for pipelines may be divided into three basic systems:

1. Asphalt coatings. These consist of pure air-blown asphalt with a softening point in the range generally used for "pipe dip"—180 to 200 deg F. These coatings are very often not wrapped.

2. Pipeline enamel. This is an air-blown asphalt combined with mineral fillers, generally having a softening point in the range of 210 to 260 deg F. It is usually applied in a thickness of 3/32 in., and is used almost always in conjunction with wrappings.

3. Mastic systems. Mastic is a combination of asphalt, mineral aggregate, mineral filler and asbestos, generally applied no less than ¼ in. thick.

Since asphalt is the main ingredient in the three systems enumerated above, it is appropriate to discuss its derivation as generally used in pipe coatings.

The refiner of petroleum products for use in the manufacture of asphalt pipe coatings must specifically select his crude oils so as to derive an asphalt having the physical properties known to yield a durable pipe-lining material. This selection can only be made in conjunction with laboratory investigations and refining experience.

The selected crude oil is subjected to atmospheric and vacuum distillation to remove the gasoline, kerosene, diesel oils, and lubricating oils, leaving a residuum of the required properties for a pipe-coating base "flux." This flux is then subjected to an air-blowing operation that raises its softening point—which may be considered as increasing its "toughness." After it has been determined that the softening point and other physical properties are at the proper level, the air-blown asphalt is "filled" with finely divided mineral—often 15 to 20 percent by weight.

Asphalt coatings (pipedips) are usually relegated to pipe of smaller diameters, where the problem is maximum protection at minimum cost. This pipe coating has a lower density than enamel or mastic, and as such it is more susceptible to impact damage and flow which determine the coating quality.

While field wrapping of tape, either by hand or by machine, accounts for a large part of the tape used, an increasing amount of tape is being applied with stationary equipment at the sites or in the yard. Though application costs with stationary equipment are somewhat higher than over-the-ditch applications, they are competitive with pre-applied coatings of hot dope. All tape coatings, regardless of the method of application, should be applied uniformly, under tension. They should be free of wrinkles, voids and breaks.

The availability of field wrapping equipment, which lessens application costs, has had a direct effect on the cost of the tape. Ten years ago, the price per square (100 sq ft), of tape in the 10- to 14-mil thickness bracket was about $23, while the current price is less than $13. For quantity purchasers, accessory handroll sizes, the price per square is less than $7.50. Pipeline rolls, which are available in widths up to 18 in. and lengths up to 800 ft, are priced at less than $6.50 per square. Tape coating prices are quoted delivered, freight prepaid, to the job site.

On the basis of the above quantity prices for accessory rolls, the cost per foot for various pipe diameters would be as follows:

Pipe Diam., in.	Tape Width, in.	Lap, in.	Cost per lin ft
2	4	½	$0.0498
4	6	½	0.0959
6	9	½	0.136
8	9	½	0.178
10	9	½	0.22

Using the lower pipeline roll price and standard specifications for tape width and overlap, the cost of the material per foot on 20-in. pipe would be $0.335.

A major use of tape is as a field joint and repair material. The utility of a cold-applied material is evident when field work is done in congested areas, often on busy streets, where there is always the danger of fire or fumes. The production rate of experienced workmen using tape will exceed that using hot-applied materials. Material costs will vary depending on pipe diameter, cut-back, tape width and overlap. Some typical costs per joint, using a general standard specification, with a 6-in. cut-back and a ½-in. lap, would be as follows:

Pipe Diam.	Tape Width	Cost per Joint
¾ in.	2 in.	$0.04
2 in.	2 in.	0.08
8 in.	6 in.	0.28

Tape is just over ten years old but experience has revealed no signs of deterioration of either the plastic film or the adhesive. Any other inferences as to the life of the tape must be based on its known extreme inertness and stability under a wide range of environments.

INTRODUCTION

A symposium sponsored by the ASCE Pipeline Division at the Reno Convention in June consisted of five papers. A proponent of each product prepared the presentation with eleven characteristics in mind: (1) composition and makeup, (2) method of application, (3) desirable areas of application, (4) cost range, (5) electrical resistivity characteristics, (6) imperviousness, (7) durability, (8) method of protecting joints, (9) method of making repairs on holidays, (10) expected life, and (11) effectiveness of cathodic protection.

There was no intent to determine which coating is most suitable; in fact most speakers concluded with the comment that no one coating is best for all conditions. Their comments, condensed but not intentionally changed, are presented to stimulate investigation of the several products as to their suitability for a given project.

than either the enamel or the mastic. However, it is very easy to apply by hot dip and is often used to protect pipe of smaller diameter in less critical service. Asphalt enamels are either yard or field applied at temperatures around 450 deg F. A spiral reinforcement and outside wrappings are immediately applied while the enamel is hot.

Asphalt protective pipe coverings are most economical and have a proven service record. A ton of asphalt enamel in bulk shipment for a large contract will sell for around $30 at the point of manufacture. At a rate of application for an estimated thickness of 3/32 in., the resulting cost per square foot of protection will be about ¾ cents. On the basis that a square foot of pipeline felt and a square foot of pipeline glass will cost in the neighborhood of 2½ cents, the total raw-material cost per square foot of a wrapped asphalt enamel system is in the neighborhood of 3¼ cents. This figure does not include labor for application, freight, or any contingent costs. Furthermore it is of course based on a large and continuous operation.

Water resistance

Water resistance is generally divided into two categories—water absorption and water permeability. Much has been said about each of these phenomena and ultimately the basis for any determination of either absorption or permeability is very much dependent on the method of test chosen. Pfeiffer in the publication, "The Properties of Asphaltic Bitumen," states that the water absorption found for an essentially salt free, unfilled asphalt was in the range of 0.001 to 0.01 percent by weight.

Water permeability also is very slight, and it is known that permeability is lowered by the addition of finely divided mineral matter. The thickness of the asphalt film in a pipeline enamel system, being in the range of 0.090 in., eliminates the effect of the surface permeability phenomenon. For example, in the work done by the Husky Oil Company on asphalts in the form of films about 0.090 in. thick, the water permeability was determined at 0.13 oz per sq in. per year.

The actual mass of asphalt enamel coatings and the accompanying reinforcing of the wrapping agents have been proved to give good resistance to underground stresses. Any displacement due to soil stresses is a gradual thing which occurs at a slower rate as the penetrating objects get closer to the interface.

Local experience in Southern California indicates that more than twenty years of satisfactory service can be obtained from single-wrapped asphalt enamel systems. The National Bureau of Standards (Underground Corrosion, Circular No. 579) reports that a 3/32-in., machine-field-wrapped, asbestos-felt installation was in "excellent" condition after 13 years. Unwrapped adjacent sections were beyond recovery.

3. Cement Mortar

C. E. LAMAR, Southern Pipe, Division of U.S. Industries, Inc., Azusa, Calif.

Cement mortar, as it is discussed here, is a protective coating applied to a steel cylinder of a thickness sufficient to withstand the internal stresses. It is natural to protect steel pipe with cement mortar. Steel is compatible with the alkaline nature of cement and is not injured by it. Also, it is the one lining and coating that can really contribute to the mechanical strength of the pipe against external loading. New, modern standards and specifications for mortar coatings are in process of development by government agencies, the American Water Works Association, manufacturers, and others.

Cement-mortar coatings are basically composed of: (1) a rather fine and uniformly graded sand aggregate, (2) portland cement (usually without additives), and (3) the minimum amount of water needed for hydration. Varying types of reinforcement, aggregate, and cement are utilized to tailor the production to the specific job. For instance, Type II cement is commonly used in water works applications, while Type V is more usual in sanitary sewer pipelines. Application of the cement on the outside of the pipe utilizes a mechanical method of applying a premixed mortar. The methods range from counter-rotating brushes to steam guns, which expel the cement mortar against the pipe while it is rotated on a lathe-type machine. On some of the larger sizes of pipe, where extremely thick coatings are desired, form-cast methods are sometimes used.

The decision to use cement mortar for a protective pipe coating is of course best determined after a detailed analysis by a qualified engineer. However, it may be stated that in general it is best for permanently installed pipelines where the fluid is not reactive with the mortar lining, or the soil with the outside mortar coating. This is the case in nearly all areas of the southwestern United States that have alkaline environments and alkaline water. For example, cement-mortar linings should not be used with sour crude oil or with water containing a large amount of entrained CO_2. Applications are most successful where the water or soil pH is between 5.5 and 8.5.

Cement mortar is a very useful coating where its desirable features can be utilized. Such a feature as high early strength, for ease of handling, is important to the manufacturer. The design engineer may be interested in resistance to soil and water corrosion, heavy weight, thickness of coating, rigidity, and its superb ability to withstand abuse. Obviously these are not always advantages, as it is not desirable to use a heavy pipe where job access is difficult, where there are long spans and the like.

Only generalized cost ranges can be given because of the versatility of specifications for cement mortar which enable it to be tailored to the particular job. Typical costs are 15 to 25 cents

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4. Somastic Materials

HOWARD E. LYMAN, Pipe Linings, Inc., Wilmington, Calif.

Somastic pipe coatings have been used since 1932. Many of the original lines are still in service. Somastic is made up of asphalt binder, mineral aggregate, mineral filler and asbestos fiber. The asphalt binder is a petroleum asphalt of uniform character. The grade used should meet the requirements of the pipeline operating temperature. Somastic has four grades: No. 1, for 80 deg F; No. 2, for 125 deg F; No. 3, for 160 deg F; and No. 4, for 200 deg F. The exterior white coating consists of quick lime, slowly mixed with water in proper proportions.

Somastic is heated and extruded seamlessly onto the pipe after all oil and grease have been removed and the surface thoroughly cleaned by blasting. The primer is usually applied uniformly to the surface by spraying but it also can be applied by brush. The mineral aggregate is thoroughly dried and heated to not over 450 deg F, then run into a pug mill, where it is mixed with the proper amount of asphalt and limestone dust. The resulting temperature of the mastic is between 280 and 350 deg.

The hot mastic mixture is applied to the primed surface by extrusion. When completed, the coating is immediately given an electrical inspection with a holiday detector, using 40,000 volts. All defective areas are repaired. If any length of pipe has more than six holidays, the mastic coating is taken off and a complete new coating is applied.

The coating can be applied to either new or reconditioned pipe in diameters from ½ in. to 30 in. and larger. The minimum thickness of the mastic coating is ¼ in.; the nominal thickness on 8-in. pipe is ½ in. An advantage of somastic coatings is that through their use the wall thickness of steel pipe can be reduced to the minimum required by operating pressures. This can result in a substantial monetary saving. For example, one of the major oil companies used pipe of lighter weight for its waste oil line, and the saving in cost helped to pay for the somastic coating.

Somastic pipe coating compares favorably in price with many of the bituminous coatings. Carload quantities of steel pipe (40,000 lb) up to 6 in. in diameter can be coated for 20 to 25 cents per sq ft—with lower prices for larger quantities.

Many factors influence the electrical resistance of a given coating. Its thickness is a major factor and its resistance to water absorption is also very important. When the coating has been damaged in any way from handling, clod pressure, soil stress, or weed penetration, it will have a higher electrical conductance. The pipe will then have a less protected and a shorter life.

The permeability rate for somastic is even lower than that for straight bituminous coatings. This is because of the non-permeable nature of the aggregate. Also, because of the heterogeneous nature of the somastic, moisture must follow a circuitous path which is much longer than the actual coating thickness.

Pressure clamps are used to make protection seamless and continuous at joints. Hot somastic is poured into the open pressure clamp which, when filled, is closed and tightened by turn bolts. The clamp is removed in about 30 minutes. Field joints can be provided as per sq ft for linings, and 20 to 40 cents per sq ft for coatings. These, in general, are in the same range as the better specifications for asphalt enamels, mastics, and coal-tar enamels.

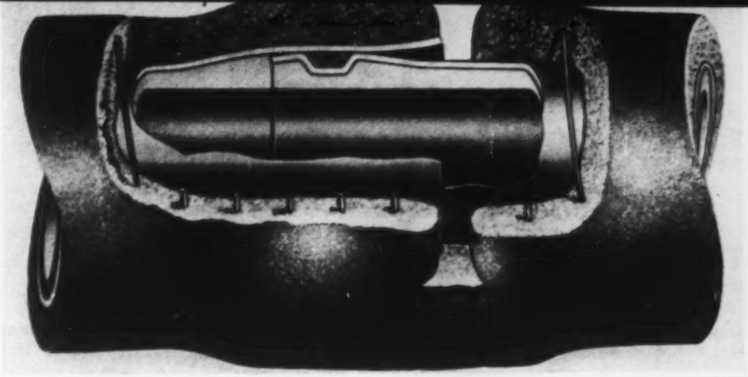
Among the most useful characteristics of cement mortar are its resistance to wear and its durability in underground service. From a mechanical standpoint, cement mortar is adaptable to any soil, almost without regard to imbedded rocks and loading. The pipe is easy to haul, handle, and install, and it does not require a special treatment of the trench bottom, as do some of the more delicate materials. This ease of handling is reflected in lower installation costs for pipe coated with cement mortar. In addition, cement-mortar linings provide a continued high-flow factor and allow for severe cleaning of the inside where this is necessary as a result of special conditions. An example is in the oil fields, where rapidly cooling materials are transported and the resulting hard mineral deposits must be removed by steel "pigs" passed through the line.

Holidays on cement-mortar-protected pipe are unknown as such. Minor cracks present no problem as the coating does not have to be perfect to protect, as is the case with many other coatings. Large cracks, gaps, and damaged areas can be hand-packed in a method similar to that used to cement field joints. In general, this is done by applying a rich mixture of cement mortar over a bonding layer of neat cement.

Cathodic protection, although it is seldom necessary, is easily done in rare cases where needed, either with a cement-mortar coating or with a cement-mortar overcoat over bitumastic coatings.

As for the normal expected life of cement-mortar coatings under average conditions, this is also a very broad subject, and vague enough to require specific investigation for each job. Failures of cement-mortar lined and coated pipe are practically unknown.

All in all, cement mortar answers most, but certainly not all, of the needs for a pipe coating. Every coating has a use, but cement mortar can provide many features not found in others.



Cutaway view of cement-mortar lined and coated pipe. Note helically wrapped reinforcing wire near center of coating.

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fast as required by the laying contractor. Bends or special fittings are coated by hand troweling.

Each piece of somastic-coated pipe is electrically tested to detect holidays. If a holiday is found, the coating in the area is removed and repaired by hand troweling of new somastic material into the area. These areas are usually 1½ in. in diameter or less. Heat is applied with a blow torch to be sure of a perfect bond, and the pipe is again checked.

Somastic coating is a non-conductor of electric current. A minimum of cathodic protection is needed even in the "hottest" soils. On a new 10¾-in. line, 23 miles in length, one anode station protected 312,000 sq ft. Of course overprotection can be very harmful—1½ volts can damage somastic.

Fifty years or more is believed to be the normal life expectancy of a somastic-coated line. However, in searching for the ideal pipe coating, it must be remembered that the best coating for one project may be entirely unsatisfactory for another. Soil conditions, weather conditions, operating conditions and economic considerations must all be thoroughly evaluated before a given coating is specified.

Field joint in foreground was made by mechanical pressure molds. Hot somastic was poured into open pressure clamp which, when filled, was closed and tightened. The clamp was removed in about 30 min, giving continuous protection at joint.

5. Coal Tar

H. E. TILLMAN, Koppers Company, Inc., Los Angeles, Calif.

There are several different formulations of coal-tar enamel to meet different requirements of temperature, exposure and surface hardness. The various types or grades do not differ, to any measurable extent, in insulating value and water resistance; their selection is based on physical conditions before backfill, or expected operating temperatures.

Coal tar for enamel is derived from the coking of coal in steel mills. This tar is refined in modern plants to form the coal-tar pitch base from which enamel is made. To the pitch is added plasticizers and fillers to obtain the desirable characteristics. The enamel is a black, thermal-setting material.

Steel pipe to be coated with coal-tar enamel is first cleaned thoroughly—preferably by steel grit or sandblasting. Then a coal-tar-base primer or a fast-drying resin-base primer is applied cold. Over the dry primer, the enamel is applied in a hot, molten state. On pipe it is usually applied mechanically—in coating plants or by special coating machines, which ride the pipe over the ditch. It may also be applied by hand with tampico daubers.

Application temperatures vary with the type of enamel, ranging from 375 to 530 deg F. Thickness of the enamel is usually about 3⁄32 in. Generally a wrap of glass mat is embedded in the enamel for reinforcement, and an outer wrap of tar-saturated asbestos felt is applied to protect the enamel from physical damage.

Coal-tar enamel is the most economical coating for underground pipe where long-term service is desired. It is suitable for operating temperatures up to 200 deg F, and for all sizes of pipe.

When enamel is used on pipe above ground, it should be top-coated with a coal-tar emulsion, and when used in sea water it should have an outer jacket of reinforced cement mortar to prevent barnacle penetration.

The applied cost of a coal-tar enamel coating, including blast cleaning, will range from 15 to 25 cents per sq ft, depending on the quantity of pipe, the coating specifications, and the location. For instance, for a typical coating specification carried out on the West Coast, one might expect to pay 30 cents per lin ft for 6-in. pipe, 45 cents for 10-in., and 65 cents for 16-in. However, these figures represent only first costs and can be misleading when the design engineer is making a selection inevitably dominated by economic factors. To determine the real cost, it is necessary to add the maintenance cost to be expected over the years of service life expected from the pipeline. By maintenance cost is meant the cost of installing cathodic protection and maintaining it, plus leak repairs if any.

The dielectric strength of coal tar is extremely high. It is in the range of 10^{12} to 10^{15} ohms per cu cm. Many satisfactory experience records extending over fifty years indicate that coal tar maintains its high electrical resistance characteristics.

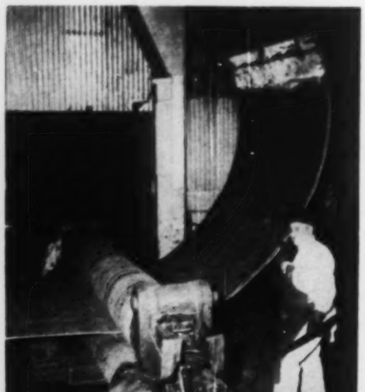
Many laboratory tests have been run over the years to determine the effect of water on coatings. Such tests have been conducted by government agencies, coating users, and manufacturers, and the results are readily available. These tests, to be reliable, must run from 5 to 8 years. All such tests show that coal-tar enamels have the greatest resistance to water absorption. There are many records of coal-tar installations that have been constantly submerged in water for over fifty years without being affected by it. It can safely be said that coal tar's resistance to the No. 1 underground enemy—water—is outstanding.

The principal objection to coal-tar enamel coating has been its susceptibility to physical damage. This is readily acknowledged. However, that this is not an insurmountable problem is attested by the thousands of miles of such coating successfully installed each year. Also it must be remembered that flexibility and an ability to take the expansion and contraction of pipe without cracking is usually more important than resistance to physical damage. Coal-tar enamel, reinforced with glass and wrapped with asbestos felt, provides a coating that has demonstrated its ability to withstand installation strains and severe soil stresses without damage of any consequence.

Cathodic protection is extremely effective on a line coated with coal-tar enamel because the coating remains a good insulator. Some authorities contend that coal tar is not affected by excessive current voltage. I do not subscribe to this view but recommend that the voltage be held in the range of 1 to 1½ volts. This is sufficient voltage, and with it one can be sure that the coating will be undamaged.

What is the expected life of this coating under average conditions? If there were a sure answer to this question, all the other points under discussion would be reduced to insignificance. I am convinced that the steel pipelines installed today will in most cases be in use fifty years from now, although the planned amortization period is usually 15 to 20 years. Pipelines coated with coal-tar enamel from 1914 to 1920 are still in service and probably will be for some time to come. The Los Angeles Hyperion Ocean Outfall, a line coated with coal-tar enamel, was installed in 1957—and designed for a life of one hundred years.

Below, left: Rerolling of steel strips cut from pipe of 10-ft diameter which had been in use for 20 years. Note inside coal-tar enamel coating which withstood rolling. Below, right: Coating and wrapping station for 80-ft sections of 34-in.-diam pipe.



Editor's Note: The United States, in fact the English speaking world, is falling behind by fractions, inches and miles—because of its cumbersome system of weights and measures. To us, the British monetary system seems puzzling and complicated but we do not realize that our own system of weights and measures is fully as difficult for those who have not used it from childhood. The handicap this system presents to our technical and economic progress is perhaps not realized by the average person but it should be self-evident to the engineer. A purely decimal system—and this is what the metric system is—avoids these disadvantages. Engineers especially would benefit from the use of the metric system. Mr. Hough's proposal for a gradual transition to this decimal system over the span of a full generation is worthy of careful study.

Why adopt the metric system

FLOYD W. HOUGH, F. ASCE, Chairman, Committee for the Study of the Metric System in the United States, American Geophysical Union, Washington, D. C.

This country should seriously consider and probably adopt the metric system of weights and measures as a replacement for our heterogeneous English units. Technically the metric system is simpler to use because it is decimal and requires little translation. Commercially the metric system is essential so that the United States can compete with countries able to supply drawings and goods to metric standards.

Following a period of nearly three decades of relative dormancy there is renewed interest in a change to the metric system. This interest is due at least partly to international competition in trade and to greater contact with countries using the metric system.

Bills were introduced in the recent U. S. Congress to provide for a study of the "desirability and practicability of adoption in the United States of the Metric System of weights and measures." The bills were not considered, perhaps because of the politics of an election year, but it is expected that similar measures will be presented to the next Congress.

The question immediately arises as to why the metric system of weights and measures should be considered superior to the so-called English system. The metric system, introduced by the French in 1791, is fundamentally based on a single unit of length, the meter. This unit was originally defined as a ten-millionth part of the earth's meridional quadrant. Even the kilogram, the fundamental unit of mass, was derived from the meter in that it was defined originally as the mass of pure water at maximum density contained in a volume represented by the thousandth part of a cubic meter. In 1875, the International Metric Convention, signed by 17 countries including the United States, set up the International Bureau of Weights and Measures at Sèvres, France, and made it the custodian of the international standards.

About this same time, the meter was standardized so that it now has no continuing relationship to the earth's meridional quadrant or the former meter of the Archives, but is defined, rather, as the interval between the line markings under certain physical conditions of a platinum iridium bar known as the International Prototype Meter. Likewise, the kilogram was redefined simply as the mass of the International Prototype Kilogram. Each nation adhering to the International Metric Convention was furnished a National Prototype Meter and a National Prototype Kilogram, which are compared from time to time with the International Standards at Sèvres. The U. S. Bureau of Standards is the custodian of these two national standards. On October 14, the 11th International Conference on Weights and Measures adopted a new definition for the international meter in terms of wave lengths of orange-red light produced by burning of the gas known as KR 86.

The United States has debated the question of the metric system at intervals since its introduction by the French. Numerous bills for the adoption of the system have been before the Congress since George Washington forwarded to it a copy of the French report for study. Three highly significant actions have been taken:

1. The metric system was legalized for use in the United States in 1866 by an Act of Congress.
2. The United States, in 1875, as mentioned above, became a signatory to the International Metric Convention.
3. The Secretary of the Treasury, in 1893, approved the Mendenhall Order, which recognized the International Prototype Meter and Prototype Kilogram as the fundamental standards on which the yard and pound are based.

The metric system is inherently a decimal system. The so-called English system of yards and pounds has been decimalized to some extent but is not so used generally.

Engineers have done away with the troublesome inch in favor of decimals of the foot while architects, for instance, continue to employ fractions of the inch. (Purdue University this year graduated a class of mechanical and aeronautical engineers who had been trained to work entirely with decimals

Symposium on units of measurement

The American Association for the Advancement of Science has recently published a compilation of papers from a symposium on systems of units of measurement. The volume, entitled *Systems of Units—National and International Aspects,* is edited by Carl F. Kayan. Discussed, and in some cases advocated, are English units (including the case for decimals of inches rather than fractions), metric units, and the MKSA system (meter, kilogram mass second, and ampere). The latter has recently been adopted by a number of nations and currently is being considered by others. Some thirty papers are included in the volume, which is available at $6.75 from the American Association for the Advancement of Science, 1515 Massachusetts Ave., N.W., Washington 5, D.C.

of the inch.) Some grocers now use pounds and decimals thereof, although the great majority are partial to the ounce. Most scientists and professional engineers use the metric system primarily but it is not unusual to find metric units and English units on the same page of a technical report, necessitating a mental conversion between the two systems.

Decimals are generally conceded to be far simpler to use than fractions. Suppose, for instance, it is desired to determine the area in square feet of the floor of a room that is 30 ft 9⅝ in. by 15 ft 3¼ in. These dimensions, so stated, do not lend themselves readily to multiplication. On the other hand, the product of these same dimensions measured as 9.389 meters and 4.655 meters, respectively, is easily determined as 43.706 sq meters. A similar problem in volume is even more of a contrast than the problem of area.

A highway engineer from Hawaii submits the following problem in English units and an equivalent one in the metric system:

Asphalt needed for a unit of road

COMPUTED IN ENGLISH UNITS

1 mile of road 24 ft wide

5,280 x 24 = 126,720 sq ft

0.35 gal of asphalt per sq ft is to be applied.

Taking the average specific gravity of asphalt at 1.4,

1.4 x 8.345 (weight of 1 gal of water) = 11.70 lb per gal for asphalt

11.70 x 0.35 = 4.1 lb per sq ft

126,720 x 4.1 = 519,000 lb

$$\frac{519{,}000}{2{,}240} = 232 \text{ long tons}$$

Three multiplications, one division, and reference tables were required.

COMPUTED IN METRIC UNITS

1 km of road 8 m wide = 8,000 m^2

14 liters per sq meter is to be applied.

14 x 8,000 = 112,000 liters*

= 112,000 dm^3

112,000 x 1.4 = 156,800 kg

= 156.8 metric tons

Two simple multiplications were required.

* 1 liter = 1 cu decimeter (dm^3) = 1 kg for water. In the metric system the specific gravity is the weight of 1 liter of the material.

The relative simplicity of solving this highway problem in metric units points up, in part, the outstanding advantages of the metric system: (1) that all five unit types—length, mass, area, volume and capacity—are interrelated and are based directly and solely on the two fundamental units, the meter and the kilogram; (2) that these relationships are entirely decimal in character. On the other hand, in the English system, if it may be termed a "system," there is little usable relationship among these five unit types, and customarily it is not decimalized.

In the educational field lies, perhaps, one of the greatest benefits which would accrue from our eventual abandonment of the English units in favor of the metric. Teachers of mathematics will agree that fully 25 percent of the child's time, and the teacher's as well, could be saved in arithmetic courses if the simple interrelated metric decimal units were substituted for the English. Such monstrosities as proper fractions, improper fractions, numerators, least common denominators, greatest common divisors, and mixed numbers, could be laid to rest with the celluloid collar and the oxcart. There can be no doubt among those familiar with both systems that the change from English units to metric would appreciably relieve the teaching load in our grade schools and high schools in all curricula that involve both mathematics and the sciences.

In the matter of international trade, we are clearly at a disadvantage. Britain and the United States are isolated with respect to weights and measures. About 90 percent of the world's population is living under the metric system, or their governments are in the process of changing over to it. It has been called "Russia's not secret weapon." It is believed that the preference in South America for European imports may be due, in no small way, to their use of a common "language" in the metric system of weights and measures.

One correspondent writes, "My twenty-five years of diversified experience in engineering, architecture, construction, and university teaching in Europe and America had often let me wonder why this country with its otherwise progressive and revolutionary ideas in the fields of engineering, science and industry had not switched a long time ago to the kilogram-meter system. Anyone who knows something about the metric system will admit that the English system is cumbersome, terribly time consuming and less safe against calculation errors. How elegant (and safer) is the shifting of the decimal point only in the metric system."

Another says, "It has long disturbed me personally that of two systems of units—one reasonable, convenient, and practical, and one completely irrational—residents of this country must use the latter. I am convinced that the only reason there is such complacency about the British system in this country is that the general public is not aware of the complexity of the system under which they live."

In view of the necessity for simplification and speed in its field operations, the U. S. Army in 1947 adopted the metric units as basic to its design of the Universal Transverse Mercator and the Universal Polar Stereographic grid systems. (See "A Conformal and World-Wide Military Grid System," Paper No. 2813, ASCE *Transactions*, vol. 121, 1956, p. 633.)

Further, in 1957, following ten years of experience with the meter as the unit of measurement in place of the previous national "yard," the Army published regulations to the effect that all U. S. Army weapons and related equipment will be converted to the international meter for the measurement of linear distances, this conversion to be accomplished by January 1, 1966. The North Atlantic Treaty Organization is solidly committed to the metric system, including, of course, all the defense agences of Great Britain and the United States. The same has long been true for the Russian bloc.

The American Geophysical Union became actively interested in this problem of weights and measures following its meeting in May 1958. A special committee was appointed for the Study of the Metric System in the United States. This committee subsequently conducted a poll through the medium of eight of the leading scientific and engineering magazines of the country. The response was decidedly in favor of the metric system. Of the 1,080 completed questionnaires returned from 18 professional categories, 90 percent desired a changeover from the English to the metric units and the average transition period recommended was 22 years. A partial analysis of these questionnaires is given in the accompanying Table I, taken from the December 1959 *Transactions* of the American Geophysical Union.

The committee pointed out, in its letter to the editors accompanying the questionnaire, that bills for the adoption of the metric system exclusively in the United States have been more than once presented to Congress, but that they have not been enacted into law, the principal reason being that in each case the proposed effective date followed too soon after passage of the bill. An early effective date would undoubtedly work a severe hardship on the adult population not familiar with the metric system, and it would make obsolete a prohibitive number of everyday items pertaining to weights and measures.

A solution would appear to be to make the metric system the only official system of weights and measures in the United States, effective in one generation (33 years) after the passage of the legislation. Following this action by Congress, the grade schools and high schools would begin immediately to teach children the metric along with the English system and, during the transition period, would place more and more emphasis on the metric system. At the end of the transition period the English system would still be taught, but the emphasis would be just the reverse of what it is today.

A long transition period would result in a smooth change. In a generation most items of equipment involving weights and measures normally become obsolete or are worn out and replaced. Also, persons engaged in professions and trades now using the English system exclusively would normally retire during this period and would be replaced by a new generation fully trained in the metric system.

When we recall that our founders saw fit to break away from the British nightmare of pounds, shillings, pence, guineas, and florins, and set the new country straight with a decimal monetary system, it seems strange that they retained the equally atrocious British system of weights and measures. Perhaps the pace of the times, unlike that of today, did not demand the efficiency and precision in calculations with which we are faced and which will become even more exacting in the years ahead.

Clearly, there is now in the United States a revival of interest in securing a better system of weights and measures following a period of some three decades of complacency. In this electronic age of accelerated progress and ever closer ties with other nations, it is imperative that something be done about the inexcusable complexity and non-conformity of the so-called English system of weights and measures. It must not be done overnight; our economy is too expansive. However, by providing a long transition period extending over a generation, we can readily convert without hardship or economic dislocation. We can adopt officially the simple interrelated units first presented to the Congress by President George Washington in January 1795, thus securing for our own country the very considerable advantages of the metric system of weights and measures.

TABLE I. Analysis of questionnaire on the metric system

(All figures are percentages except where otherwise noted)

		Present Usage (Ques. 2)				Change Advantageous (Ques. 3)			Period for Change, years (Ques. 4)		Use Centigrade Temperature (Ques. 5)		
Profession*	No. Answering	Metric	British	Other	Answering	Yes	No	Answering	Aver. Years	Answering	Yes	No	Answering
1	149	68	29	3	99	93	7	99	22	97	95	5	98
2	150	74	24	2	99	96	4	99	21	96	98	2	99
3	16	30	59	11	100	80	20	94	24	100	80	20	94
4	179	24	73	3	98	90	10	99	21	96	94	6	99
5	121	41	56	2	97	90	10	100	25	97	97	3	98
6	84	15	80	5	98	81	19	100	24	95	88	12	98
7	39	45	55	0	92	92	8	100	18	95	92	8	100
8	38	16	83	0	92	82	18	100	26	92	86	14	92
9	27	37	55	7	100	100	0	100	19	100	100	0	100
Total or av. for above 9 categories	803	39	57	4	97	90	10	99	22	96	92	8	98
Total or av. for full questionnaire	1,080	45	52	3	98	90	10	99	22	96	94	6	98

	Export Trade Now Suffering (Ques. 6)			Metric System Adaption Inevitable (Ques. 7)			Cost of Gradual Change Prohibitive (Ques. 8)			Sponsorship (Ques. 9)				
Profession*	Yes	No	Answering	Yes	No	Answering	Yes	No	Answering	Prof. Soc.	Industry	Education	Gov't.	Answering
1	67	33	41	65	35	95	8	92	91	35	13	19	33	96
2	61	39	43	72	28	97	5	95	97	38	10	10	43	98
3	50	50	38	31	69	100	0	100	100	24	17	24	36	88
4	72	28	38	80	20	72	7	93	72	37	16	14	33	99
5	68	32	55	63	37	98	8	92	98	35	13	11	41	99
6	64	36	60	72	28	99	13	88	95	27	19	9	45	98
7	58	42	49	64	36	92	3	97	92	34	15	4	46	100
8	76	24	45	46	54	92	3	97	92	33	7	10	50	89
9	65	35	63	68	32	93	4	96	96	31	27	15	27	96
Av. for above 9 categories	65	35	48	62	38	95	6	94	92	33	15	13	39	96
Av. for full questionnaire	68	32	46	68	32	92	8	92	91	34	15	13	39	97

This Table I is from a Progress Report of the Committee for the Study of the Metric System in the United States, of the American Geophysical Union.

* Key to professions (the original questionnaire covered nine additional categories):

1 Physics
2 Chemistry
3 Mathematics
4 Civil engineering
5 Electrical engineering
6 Mechanical engineering
7 Geology
8 Aerodynamics
9 Photogrammetry

ENGINEERS' NOTEBOOK

Slope distances by slide rule

BURTON G. DWYRE, F. ASCE, Chief Highway Engineer

Gordon Herkenhoff & Associates, Inc., Santa Fe, N. Mex.

In making surveys in the field it is often more accurate to measure the slope distance between two established points and calculate the horizontal distance corresponding to the slope angle and slope distance measured.

The following method of calculating horizontal distances by slide rule is accurate to 0.05 ft on an ordinary slide rule for the usual slope angles.

Select an angle large enough to cover the slopes likely to be encountered in the work to be done.

Set the natural versed sine of this angle on Scale A. Set the number representing the angle selected on Scale C opposite the natural versed sine on Scale A. Read the natural versed sine on Scale A opposite the number representing the slope angle on Scale C. Multiply the natural versed sine of the slope angle by the slope distance and subtract the product from the slope distance to get the horizontal distance.

Example

Slope angle = 13°21′. Slope distance = 298.21 ft.

Set versed sine for 25 deg (0.094) on Scale A. Set 25 on Scale C opposite 0.094 on Scale A. Read 0.027 on Scale A opposite 13° 21′ on Scale C.

0.027 × 298.21 = 8.05
298.21 − 8.05 = 290.16

Thus 290.16 is the horizontal distance required.

Check

298.21 × (cosin 13°21′) 0.9729777 = 290.14

THE READERS WRITE

Deflections found by conjugate-beam method

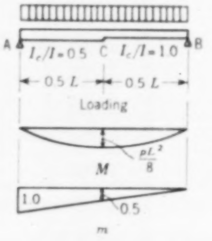
To the Editor: Concerning the "deflection calculations" by H. H. Fickel in the June 1960 issue, p. 70, and the discussion by R. C. Lofgren in the August 1960 issue, p. 93, a further illustration is given here to stress the advantageous simplicity of the conjugate-beam procedure.

Table I applies to a 20-segment beam in which the span is divided into 20 equal divisions where the r's express I_c/I at the middle of each division. Actually the member is divided into 21 segments, but the end segments are of only half length. In Mr. Fickel's Fig. 2 (June issue, p. 71), reprinted at right, r equals ½ for each segment in the left half of the beam, while $r' = 1$ for the right half.

To get the rotation θ_A at the left end of the beam, we merely add the quantities horizontally (see Table I), dividing 31.22 equally with the left and right halves, thus:

$EI_c\theta_A$ [same as $EI_c\delta$] $= (10)^{-4} \times$
$[(\tfrac{1}{2})(286.06) + 130.62]$
$= (10)^{-4}\,[273.65]\,pL^3$

which is practically equivalent to (7/256) pL^3, the result according to Mr. Fickel's method.



Among the other coefficients in this table are those giving deflections at each 10th point of the beam. Thus, the simple-beam deflection at the middle (Point 10 in Fig. 2) is

$EI_cy_{10} = (10)^{-4}\,[(\tfrac{1}{2})\,(65.10) + 65.10]pL^4$
$= (10)^{-4}\,(97.65)pL^4$

The effect of restraining moments, if any, might be found separately from another table similar to Table I, where the rotations and deflections are produced by unit couples at ends "A" and "B" respectively.

T. F. Hickerson, M. ASCE
Formerly Prof. of Civil Eng.
Univ. of North Carolina
Chapel Hill, N. C.

TABLE I. Load coefficients, end rotations, and deflections at each 1-ft point of a 20-ft beam with uniform

	0	1	2	3	4	5	6	7	8	9	10	9	8
F	1.54	11.82	22.45	31.82	39.95	46.82	52.45	56.82	59.95	61.82	62.45	61.82	59.95
θ_L	1.51	11.18	20.16	27.01	31.93	35.09	36.69	36.92	35.96	34.00	31.22	27.83	24.00
θ_R	0.03	0.64	2.29	4.81	8.02	11.73	15.76	19.90	24.00	27.83	31.22	34.00	35.96
y_2	0.02	0.58	1.90	2.70	3.19	3.51	3.67	3.69	3.60	3.40	3.12	2.78	2.40
y_4	0.02	0.51	1.83	3.85	6.15	7.02	7.34	7.38	7.19	6.80	6.24	5.57	4.80
y_6	0.02	0.45	1.60	3.37	5.61	8.21	10.69	11.08	10.79	10.20	9.37	8.35	7.20
y_8	0.02	0.38	1.37	2.89	4.81	7.04	9.45	11.94	14.01	13.60	12.49	11.13	9.60
y_{10}	0.01	0.32	1.14	2.40	4.01	5.87	7.88	9.95	12.00	13.91	15.22	13.91	12.00
y_8'	0.01	0.26	0.91	1.92	3.21	4.69	6.30	7.96	9.60	11.13	12.49	13.60	14.01
y_6'	0.01	0.19	0.69	1.44	2.41	3.52	4.73	5.97	7.20	8.35	9.37	10.20	10.79
y_4'	0.01	0.13	0.46	0.96	1.60	2.35	3.15	3.98	4.80	5.57	6.24	6.80	7.19
y_2'	0.00	0.06	0.23	0.48	0.80	1.17	1.58	1.99	2.40	2.78	3.12	3.40	3.60

Beam symmetrical: $r_0' = r_0$, $r_1' = r_1$, $r_2' = r_2$, etc.

	0	1	2	3	4	5	6	7	8	9	10	Sum $r's = 1$
F	3.07	23.65	44.90	63.65	79.90	93.65	104.90	113.65	119.90	123.65	62.45	833.33
$\theta_L = \theta_R$	1.54	11.82	22.45	31.82	39.95	46.82	52.45	56.82	59.95	61.82	31.22	416.67
$y_2 = y_2'$	0.03	0.65	2.13	3.18	3.99	4.68	5.24	5.68	5.99	6.18	3.12	40.87
$y_4 = y_4'$	0.03	0.64	2.29	4.81	7.75	9.36	10.49	11.36	11.99	12.36	6.24	77.33
$y_6 = y_6'$	0.03	0.64	2.29	4.81	8.02	11.73	15.41	17.05	17.98	18.55	9.37	105.87
$y_8 = y_8'$	0.03	0.64	2.29	4.81	8.02	11.73	15.75	19.90	23.61	24.73	12.49	124.00
y_{10}	0.03	0.64	2.29	4.81	8.02	11.73	15.75	19.90	23.99	27.83	15.22	130.21

Railroads are taxpayers with a large unused capacity

To the Editor: "By-line Washington" in the September 1960 issue, p. 90, stated: "The average annual increase in waterways freight tonnage over the past 11 years—7.8 billion ton-miles—is the equivalent of adding a new transcontinental railroad, 2,600 miles long, to the nation's system each year. Railroads as they now exist could not even absorb the annual increase—much less the basic tonnage—without huge additional investments. The report suggests the U.S. might spend another $7.9 billion on waterways to enable them to handle increases to the year 2000."

Your readers will be interested in excerpts from a letter on this subject by Daniel P. Loomis, President, Association of American Railroads, dated September 12, and addressed to the Hon. Robert S. Kerr, Chairman of the Select Committee on National Water Resources of the United States Senate. Copies were sent to the Hon. Wilber M. Brucker, Secretary of the Army, and Lt. Gen. Emerson C. Itschner, F. ASCE, Chief of Engineers. Mr. Loomis said in part:

"Waterway traffic is generally bulk traffic in areas of heavy traffic concentration, and this traffic density is compared [by the Army Engineers] with the average traffic of all rail lines including branch lines handling almost insignificant traffic per mile of road.

"The waterway traffic increases between 1946 and 1957 occurred on a system of waterways where traffic is concentrated, waterways upon which the taxpayers, using figures from the report, have already invested 5½ billion dollars through the Federal Government, plus 'sizeable non-Federal contributions,' for construction, improvement, maintenance and operation. Further expenditures of almost eight billion taxpayer dollars are suggested to provide additional waterway facilities to compete with existing parallel railroads which provide their own facilities from their own resources, and pay taxes besides.

"The Corps confuses rail *capacity* to move traffic with *use* of rails to move traffic. It also fails to recognize that much of the increase in inland waterway traffic is traffic diverted from the self-supporting, privately-owned, taxpaying railroads to the public-supported, publicly-owned, tax-consuming waterways. . . .

"Going back to World War II, which preceded the almost complete dieselization of the railroads, and prior to many of the other railroad operational improvements, the upper level of use on heavy traffic segments exceeded 80,000,000 ton-miles per mile of road per year. This figure would be considerably higher today if the traffic were available.

"Again, assuming traffic were available, one such railroad 1,000 miles long, the rail distance from Pittsburgh to New Orleans (instead of 1,717 miles of waterway distance), would have capacity to handle over 80 billion ton-miles of traffic a year—enough to absorb the annual increase of 2.3 billion ton-miles of waterway traffic for 35 years—without any cost to the taxpayers. More significant is that it would not be necessary to build this railroad since the capacity of existing lines in this area is already adequate to handle this contemplated increase in traffic. . . .

"The solution is simple; if the waterway users who today pay nothing were charged with the costs of building, operating and maintaining the waterways on a basis of use, the construction of additional facilities would then be predicated upon sound economic need and not on the influence of minority pressure groups. The facilities would be paid for by those commercial interests who use them. . . ."

Hal H. Hale, F. ASCE
Asst. to Vice President
Assoc. of Amer. Railroads
Transportation Building
Washington 6, D.C.

More on expansive clay

To the Editor: The article on "Experience with Expansive Clay in Peru," by F. D. Clark, M. ASCE, in the May 1960 issue, p. 42, is of considerable interest. At the end Mr. Clark says that his experience in Talara indicates there are only two sure ways to deal with expansive clay—remove it or keep it absolutely dry.

I feel that there should be a third way. If the expansive clay is loaded up to the extent of the swelling pressure it may develop, then its uplift capability will be neutralized and there will be no movement of the foundation. Of course this will be true when the bearing capacity of the expansive soil, as determined from its shear characteristics, will justify such loading. What has Mr. Clark to say against this third way?

The corrective measures adopted consisted of an asphalt pavement 3 meters wide all around, and a French drain along the outer edge of the asphalt. How did Mr. Clark arrive at the width of 3 meters for the asphalt pavement?

In the case of sewer pipe, he recommends that where the pipe passes through clays it be surrounded with at least one foot of sand. What about foundation bedding for the pipe in this case?

N. Sanyal, F. ASCE
Indian Refineries Limited
New Delhi, India

Author's reply

To the Editor: In reply to Mr. Sanyal's letter [above] I will answer his three questions as follows:

1. Mr. Sanyal suggests that the foundation pressure be balanced against the uplift pressure of the expansive clay so that the bearing capacity of the clay will not be exceeded. His idea is interesting and I would like to hear the results if he tries it.
2. The width of three meters for the asphalt pavement was arrived at by the use of two factors engineers frequently must rely on—"experience and judgment."
3. The pipe in question was in sizes of 12 in. and under. The sand beneath the pipe was carefully tamped to grade and no difficulties were encountered.

In reply to Mr. Low's letter in the September issue, p. 74:

Mr. Low's comments on the heaving of pavements placed over expansive clay are certainly pertinent. I have found that heave can be minimized by placing a layer of coarse-grained material 8 to 12 in. thick directly under the pavement, providing that the coarse-grained material is connected to a drain. When protecting a foundation by surrounding pavement, it is important to provide drainage for the moisture that tends to accumulate under the pavement. Otherwise the effort is, in Mr. Low's words, "doomed to failure."

Forrest D. Clark, M. ASCE
Chief Estimater, Abadan Refinery
Iranian Oil Refining Co.
Abadan, Iran

load of w lb per ft

7	6	5	4	3	2	1	0	Sum r's = 1
56.82	52.45	46.82	39.95	31.82	22.45	11.82	1.54	833.33
19.90	15.76	11.73	8.02	4.81	2.29	0.64	0.03	416.67
36.92	36.69	35.09	31.93	27.01	20.16	11.18	1.51	416.67
1.99	1.58	1.17	0.80	0.48	0.23	0.06	0.00	40.87
3.98	3.15	2.35	1.60	0.96	0.46	0.13	0.01	77.33
5.97	4.73	3.52	2.41	1.44	0.69	0.19	0.01	105.87
7.96	6.30	4.69	3.21	1.92	0.91	0.26	0.01	124.00
9.95	7.88	5.87	4.01	2.40	1.14	0.32	0.01	130.21
11.94	9.45	7.04	4.81	2.89	1.37	0.38	0.02	124.00
11.18	10.69	8.21	5.61	3.37	1.60	0.45	0.02	105.87
7.38	7.34	7.02	6.15	3.85	1.83	0.51	0.02	77.33
3.69	3.67	3.51	3.19	2.70	1.90	0.58	0.02	40.87

Multiply the appropriate tabular quantities by the corresponding values of r [where $r = I/I_0$]. Sum up the results, then multiply by $\frac{1}{10^4}$ to get F or θ. Multiply by $\frac{wL^4}{EI_0} \times \frac{1}{10^4}$ to get y.

Note that $F\,\bar{x} = \theta_A \times L$.

ASCE NEWS

Joint Task Committee on Prestressed Concrete

The first meeting of the Control Group of the newly reorganized Joint ASCE-ACI Committee, "Task Committee on Prestressed Concrete," was held in Chicago on September 6 to initiate activity.

The aim of the group is: "To continuously evaluate the technical status of prestressed concrete and to recommend to the joint sponsors the formation of any needed technical committees or subcommittees for the study of particular developments, innovations, or problems arising in the field." Committee activity will be directed toward the publication of information and the development of tentative recommendations or recommended practices. The committee will also study and make recommendations on significant research problems.

Out of some 28 items that had been suggested for committee work, the Control Group gave first priority to the following:

1. Steam curing of prestressed concrete members
2. Shear
3. Use of entrained air in mixes for prestressed concrete
4. Bond of pretensioning steel
5. Deflection, camber and vibration
6. Reevaluation of allowable stresses under working loads
7. Minimum percentages of steel

Several other second-priority topics will also receive attention in the near future. These are:

1. End block stresses
2. Evaluation of forces due to creep and shrinkage introduced into prestressed elements and their effects on the remaining elements of a structure
3. Long prestressed concrete columns
4. Torsion and stability
5. Design concepts for prestressed plates and slabs

It was recognized by the Control Group that many of these subjects fall within the jurisdiction of certain existing committees of both ASCE and ACI. For this reason, such committees will be contacted by the subcommittee chairman before any activity is undertaken by the Prestressing Committee.

It will be appreciated if members of ASCE having pertinent information on any of the topics, will forward it to M. Schupack, chairman; or W. B. Bennett, secretary, of the Control Group.

Civil Defense Data Mailed to Members

Members have received a first mailing of publications intended as a guide for civil engineers in planning and building for civil defense. This material, which has been prepared by the Office of Civil and Defense Mobilization, is being made available as the inital step in a joint program of the OCDM and the ASCE Coordinating Committee on Civil Defense. The joint program is aimed at assuring all Society members the latest civil defense information in civil engineering areas (October issue, page 96).

The first mailing features a Technical Manual, entitled "Fallout Shelter Surveys: Guide for Architects and Engineers." It is expected that the guide will enable architects and engineers to evaluate radiation protection afforded by existing buildings, and to make preliminary designs and cost estimates for incorporating fallout structures in new shelters.

Comments are invited by Gerald R. Gallagher, Director of Research, Office of Civil and Defense Mobilization, Washington 25, D.C.

John A. Zecca

John A. Zecca Resigns As Comptroller of ASCE

John A. Zecca, Aff.ASCE, has resigned as comptroller of ASCE after thirty years on the Society staff. He became chief accountant and head of the Accounting Department in 1951. Mr. Zecca is leaving the Society to become associated with the firm of Goodbody & Co., members of the New York Stock Exchange, as a registered representative.

In a reassignment of staff responsibilities, Robert D. Phillips, who has had eight years' association with ASCE, has been named business manager, and Richard A. Jeffers, chief accountant. Bernard Fuchs, who has been on the headquarters staff for fourteen years, has been made office manager.

First ASCE Research Fellow Completes Year of Study

Robert W. Gerstner, ASCE Research Fellow for 1959-1960, has completed a year of study under the $5,000 fellowship sponsored by the Society. Mr. Gerstner spent the year at Northwestern University studying special methods in the treatment of some plane elasticity problems with particular reference to the study of dams and prestressing.

At the conclusion of his year of study Mr. Gerstner submitted a thesis to the Graduate School at Northwestern for the Ph.D. degree in the field of civil engineering. In the field of elasticity, exact solutions connot be obtained for a vast majority of problems of considerable importance. Many such problems have been solved by the use of finite differences and relaxation techniques. In his dissertation, Mr. Gerstner extended these methods to special classes of problems which arose in a study of gravity and prestressed dams. In particular, he developed two special techniques with a wide range of applicability.

The first technique concerns the case where an interface divides a body sharply into two sections having different elastic properties. This procedure is especially useful when stresses are specified on the boundaries. The second technique is a procedure which utilizes known elasticity solutions and applies a finite difference correction to obtain the complete solution.

New ASCE Research Fellowship Available

Applications for the 1961-1962 ASCE Research Fellowship will be received until January 1, 1961. The selection for the award of the grant, in the amount of $5,000, is made by the Committee on Society Fellowships, Scholarships, Grants and Bequests on the basis of the following:

- Transcript of college records
- Ability to conceive and explore original ideas
- Description of proposed research and its objectives

There is no established application form for the fellowship but applicants are reminded that six copies of the application are required. They should be sent to the Executive Secretary, ASCE, 33 West 39th St., New York 18, N.Y. For additional information and complete rules see page 156 of the 1960 Official Register, or write to the Executive Secretary.

Aid Asked in Reviewing ASCE Manual of Practice

As announced in the October issue, the Board of Direction is seeking the critical comment of the Society's membership on a proposed Manual of Engineering Practice, prepared by the Committee on Structural Dynamics of the Engineering Mechanics Division for possible publication. The Manual was written for the use of the engineering profession in the design of structures which are intended to be resistant in some degree to all the effects associated with the detonation of a nuclear weapon.

Before the Manual is released for publication, the Board of Direction will appreciate having the critical review of interested members. The comments will be used in preparation of the final manuscript.

Members wishing to review the Manual may obtain copies on a loan basis from the Executive Secretary. Copies may be kept for two weeks. Comments are due at Society headquarters before December 15.

SOCIETY AWARDS AND FELLOWSHIPS AVAILABLE

DANIEL W. MEAD PRIZES:	*1961 contest closes May 1, 1961. See 1960 Official Register, page 149. Topic for 1961 contest announced in July issue (page 43).*
FREEMAN FELLOWSHIP:	*1961 contest closes March 1, 1961. See Official Register, page 154.*
J. WALDO SMITH HYDRAULIC FELLOWSHIP:	*1961-62 contest closes April 1, 1961. See Official Register, page 156.*
RESEARCH FELLOWSHIP:	*1961 contest closes Jan. 1, 1961. See Official Register, page 156.*
ERNEST E. HOWARD AWARD:	*Closing date Feb. 1, 1961. See Official Register, page 148.*

Buenos Aires Host to Sixth UPADI Conference

The sixth conference of the Pan American Federation of Engineering Societies (UPADI)—held in Buenos Aires, September 18-22—was attended by 110 representatives from fourteen countries, including seven delegates from the United States. President Frank Marston and Executive Secretary Wisely represented ASCE, taking advantage of the trip to include three visits with members of the Brazil Section of the Society. Messrs. Marston and Wisely also represented the Conference of Engineering Societies of Western Europe and the United States (EUSEC) and brought greetings from the group's recent plenary session in Brussels (October issue, page 98).

In the week preceding the opening of the conference, UPADI sponsored a fruitful congress on the teaching of engineering. It is expected that the congress will result in a comparative study of engineering education in the Americas similar to the recently completed EUSEC study.

Resolutions adopted at the congress include the following:

1. A plan to provide for an exchange of visiting technical lecturers between the United States and South America.
2. Provision for cooperation with the International Commission on Arbitration.
3. Encouragement of engineering participation in the establishment of common markets among nations.
4. Creation of a committee to study requirements for professional registration and licensing among the UPADI countries.
5. Appointment of a committee to bring about the establishment of general engineering libraries in Central and South America similar to the Engineering Societies Library in New York.
6. Review of standards and means for recognition of engineering technicians.
7. Various actions urging better utilization of engineers in transportation studies, in important positions in public service, and in industrial development.

The next meeting of UPADI will be held in Puerto Pico in 1962.

ASCE members get together at UPADI Conference in Buenos Aires. Shown, in usual order, are F. Athey (Engineering Institute of Canada); Executive Secretary William H. Wisely; President Frank Marston; and Manuel Font, of Puerto Rico.

Division Doings

Air Transport Division Plans Conference

A third in the series of Air Transport Conferences is being planned by the ASCE Air Transport Division. This conference, scheduled for Miami, Fla., May 8-12, 1961, will be held in cooperation with the Airport Operators Council. Its general objective will be to provide for exchange of latest information on factors affecting airport capacity. Full details of the conference will be announced soon by the Air Transport Division.

A review of conference plans was one part of the business transacted by the Air Transport Division during a recent meeting at Idlewild Airport. In addition, two new and very significant committee operations have been undertaken by the Division.

One of these committees will study, and provide an outlet for new information on airport terminal facilities. Included in such studies will be ground transportation access, parking facilities, and factors affecting site of terminal facilities. The chairman of this new committee is Ben E. Nutter, chief engineer of the Port of Oakland (California).

The other new committee will study and report on landing area facilities for airports. This includes studies of runways, taxiways, problems of air space in the vicinity of airports, and field servicing facilities. The chairman of this committee is William E. Downes, Jr., director of the Bureau of Aviation, City of Chicago.

Preliminary program for Third Air Transport Conference is received by Air Transport Division Executive Committee. Seated, left to right, are William D. Alexander, III, new vice chairman of Division; Thomas J. Fratar, Board Contact Member of Division; Reginald J. Sutherland, Division chairman; and Ronald M. White, newly elected chairman, to take office in October. Standing, in same order, are Robert Horonjeff, conference chairman and member of the Division's Executive Committee; ASCE Assistant Secretary Don P. Reynolds; and William C. Borland, Division secretary.

In the late summer the Surveying and Mapping Division's Executive Committee met at Cornell University. After taking action on a full agenda, the committee visited the Civil Engineering Survey Camp at Camp Cornell, where this photo was taken. At a special evening meeting each member of the committee addressed the students on his specialty. Prof. Arthur J. McNair, vice chairman of the committee and director of the camp, was host to the group. In attendance, also, were Earle J. Fennell, chairman; Daniel B. Ventres, Contact Member from the Board; Brother B. Austin Barry, and Franklin R. Gossett, secretary.

Hydraulics Division

C. F. Wicker, chief of the Engineering Division, U. S. Army Engineer District, Philadelphia, has been named chairman of the Hydraulics Division Committee on Research. Objectives of the committee are to initiate, organize, and coordinate programs of research and hydrology, hydromechanics, and applied hydraulics; to determine the areas in which research is required; and to promote interest in and financial support for research in cooperation with the ASCE Committee on Research.

Pipeline Division

Research needed to ascertain certain values pertinent to the design of pipeline crossings, is being conducted by the Research Council on Pipeline Crossings of Railroads and Highways. Through its Pipeline Division, ASCE is playing a vital role in the Council by handling administrative details such as the execution of contracts and payment of funds.

The work of the Council is supported by some twelve organizations interested in the pipeline industry. For the next five years the Council will conduct the following three basic phases of research: (1) Examination of the actual performance of steel casing installed under railroads and highways; (2) laboratory investigation of the modulus of passive soil resistance and other pertinent soil factors; and (3) a full-scale laboratory examination of uncased carrier pipe performance under various soil and surface loads.

It is hoped that within the next two years, sufficient information can be obtained from these research programs to establish design criteria for proposed specifications to be submitted to the American Standards Association.

Five Engineers Win ASCE Research Prizes

Nominations for the ASCE Research Prizes for 1960 have been made by the Society's Committee on Research and were endorsed by the Board of Direction at its Boston meeting. This year's recipients, all well known engineering educators, will be awarded their prizes at the Annual Research Luncheon, held on April 12 during the Phoenix Convention.

The winners are Raymond Clough, F. ASCE, professor of civil engineering, University of California, Berkeley, Calif.; Phil M. Ferguson, F. ASCE, professor of civil engineering, University of Texas, Austin, Tex.; Donald R. F. Harleman, M. ASCE, associate professor of hydraulics, Hydrodynamics Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.; Bruno Thurlimann, M. ASCE, professor of civil engineering, Swiss Federal Institute of Technology, Zurich, Switzerland; and David K. Todd, M. ASCE, associate professor of civil engineering, University of California, Berkeley, Calif. Biographies and photos of the winners, along with their citations, will be published in a later issue.

The ASCE Research Prizes were established in 1946 to stimulate research in civil engineering. Up to five awards are made annually to members of the Society for notable achievements in research related to civil engineering. Each award consists of $100 and a suitable certificate.

Belgian Engineers Host to EUSEC Meeting

In the late summer the Societe Royale Belge des Ingenieurs et des Industriels was host to the seventh plenary assembly of the Conference of Engineering Societies of Western Europe and the United States (EUSEC) in Brussels. Shown here, in usual order, are M. Berger Hainaut, past president of the SRBII; William H. Wisely, Executive Secretary of ASCE and retiring secretary of EUSEC; ASCE President Frank A. Marston; M. Braubant, president, SRBII; E. Hianne, secretary of the SRBII and new secretary of EUSEC; and Professor Baes, past president, SRBII. One of the important actions taken at the conference was authorization to publish the cooperative international report on engineering education, which has been under study for the past eight years (October issue, page 98).

Bakhmeteff Research Fellowship Available

A Boris A. Bakhmeteff Research Fellowship in Mechanics of Fluids is offered for the 1961-1962 academic year by the Humanities Fund, Inc., New York, N.Y. Established in honor of the late Boris Bakhmeteff, Honorary Member of ASCE and a distinguished hydraulic engineer, the award is intended for a definite research project of an original and creative nature in the general field of mechanics of fluids. The award carries an annual stipened of up to $3,000.

The recipient must be a full-time graduate student working for a master's or doctoral degree. The study and research may be undertaken at an institution of the holder's choice, if its facilities are considered adequate by the advisory Committee on Consultants. Applications must be filed by February 15, 1961, with Dean William Allan, School of Technology, The City College of New York, New York 31, N.Y. The forms for filing may be obtained from Dean Allan.

Correction in Dr. Steinman's Obituary

Through an error that is much regretted the obituary of D. B. Steinman, F. ASCE, in the September issue (page 75), referred to him as the designer of the Sydney Harbor Bridge in Australia. Information has since been received indicating that Dr. Steinman was one of a group of engineers who submitted studies for a Sydney Harbor bridge, but that he was not the designer of the present structure.

ASCE Membership as of October 9, 1960

Fellows	11,201
Members	16,100
Associate Members	18,791
Affiliates	105
Honorary Members	47
Total	46,244
(October 9, 1959	43,727)

ASCE ENGINEERING SALARY INDEX

(Prepared Semiannually)

Consulting Firms

City	Current	Previous
Atlanta	1.21	1.38
Baltimore	1.14	1.14
Boston	1.23	1.22
Chicago	1.49	1.45
Denver	1.25	1.24
Houston	1.26	1.26
Kansas City	1.15	1.13
Los Angeles	1.32	1.28
Miami	1.38	1.57
New Orleans	1.22	1.18
New York	1.29	1.25
Pittsburgh	1.07	1.07
Portland (Ore.)	1.24	1.27
San Francisco	1.34	1.30
Seattle	1.06	1.06

Highway Departments

Region	Current	Previous
I, New England	1.03	1.01
II, Mid Atlantic	1.15	1.14
III, Mid West	1.29	1.27
IV, South	1.12	1.12
V, West	1.16	1.06
VI, Far West	1.17	1.17

Sole purpose of this Index is to show salary trends. It is not a recommended salary scale. Nor is it intended as a precise measure of salary changes. The Index is computed by dividing the current total of base entrance salaries for ASCE Grades I, II, and III by an arbitrary base. The base used is $15,930, the total of salaries paid in 1956 for Federal Grades GS5, GS7 and GS9. Index figures are adjusted semiannually and published in CIVIL ENGINEERING. Latest survey was July 30, 1960.

The Younger Viewpoint

This month's editor is Judd R. Hull, of Vernon, Calif., who represents Zone IV on the Committee on Younger Member Publications.

Next year's planning?

While this year's Local Section officers and committees are finishing their work, officers for next year are meeting and appointing new committee members and chairmen. Are you in next year's planning? There is no better way for a young member to become familiar with his Local Section or enjoy his membership privilege than to serve on a committee. Local Section officers are always in need of young, energetic committeemen who can offer new ideas and help reach the goals set by their committees.

Isolated members

Recently the Los Angeles Section was approached by members within its area who are isolated from the Section and its activities by vast distances. Both the San Luis Obispo and Bakersfield areas have many civil engineers who are interested in forming a branch of the Section in their respective regions. Although certain qualifications for forming a branch must still be met, these "isolated members" are striving to take advantage of the opportunity to have an organized engineering group.

Professional engineer or technician?

What distinguishes one from the other? In the San Diego State College ASCE Student Chapter monthly paper, *Civil Tongue*, Prof. Sanford Stone sums it up in one word, "attitude." Professor Stone goes on to explain further:

"A thorough knowledge of his chosen field, the initial step being the completion of a course of study in civil engineering at a recognized engineering school. Attendance in a graduate course of study for those who can profit from this experience is highly desirable.

"A desire by the engineer to continue the learning process after his formal education is completed. One can and should continue to avail himself of informal modes of education, such as participation in non-credit university extension courses which are usually available in most of the larger cities. A further indication of the desire to learn includes association with an alert engineering organization which encourages one to keep informed of the latest developments in civil engineering theory and practice. In addition, the civil engineer would be an active and contributing member of his professional society—in this case, ASCE. He would make use of the latest engineering literature relating to his and allied fields. In this connection it should be pointed out that one of the most important services rendered by ASCE to its membership is the publication of journals detailing the latest progress in each of the several branches of civil engineering.

"It is also the responsibility of the professional civil engineer to keep himself culturally and civically alert. It goes without saying that registration as a professional civil engineer should be accomplished as soon as possible. Reward for all this effort will be manifested in the personal satisfaction of knowing that one is developing himself to serve his fellowman to his fullest capacity. Anything less than a maximum effort here can only be regarded as a waste of our most valuable natural resource, our brain power."

Public image of the engineer

Public relations, as it affects the engineering profession, has been discussed to some extent in "The Younger Viewpoint." Arnold Cogan, A.M. ASCE, co-chairman, Public Relations Committee, Professional Engineers of Oregon, writes of his activities and approach to this subject. Because of the limited space available his letter has been briefed as follows:

"In the past year we have been concentrating on public relations activities towards the goal of establishing a correct public image of the engineer."

Mr. Cogan then points out four approaches that have been adopted:

"1. Reporting current news to local news media pertaining to engineers and their accomplishments and their relationship to the public at large.

"2. Contacting newspaper editorial writers to encourage recognition of the engineer's position in the community.

"3. Contacting, personally, private firms in the area who have inadvertently identified themselves to the public as "engineers." (In one case a large insurance firm in Portland was persuaded to cease advertising as 'qualified insurance engineers.')

"4. Mailing out correspondence designed to inform the engineer of his professional place in the community and his resultant responsibilities.

"I would be very interested in hearing from engineers in other areas of the country who have programs similar to ours. Their experience, whether of failure or success, would be most helpful to us in modifying and improving our program. We feel that public relations involving engineers is a most important one, but one on which perhaps not enough time has been spent. Civil engineers, being the largest segment of our engineering family, should take the lead in developing a sound public relations attitude."

(*Note:* In regard to Mr. Cogan's comments on public relations, the Illinois Section had considerable success last year with the adoption of an award for the Chicago Civil Engineer of the Year. The local public relations committee suggested the program, developed the details, and followed up with press releases to all the newspapers. As a result, stories and pictures appeared in all four of Chicago's major newspapers including comments on the practice of civil engineering as it affects the public and the importance of the engineer's responsibility in serving the best interests of the public. The award will be presented annually to the civil engineer who is judged to have contributed significantly to the welfare of the community (Chicago metropolitan area) in following his profession during the year. He is selected on the basis of current work—preferably in the past year or two and for work that Chicagoans may recognize as a contribution to the social and economic development of the Chicago area. ASCE Past President Louis Howson was the first to be so honored last year. Ed Hoffman and Frank Klein, of the Illinois Section, did yeoman duty as members of the public relations committee in making the award a great success. ASCE Local Sections not currently making such an award can honor a local civil engineer and at the same time help develop better public relations by adopting similar programs.)

Committee on Younger Member Publications

Walter D. Linzing, Chairman; 4751 No. Paulina, Chicago 40, Ill.

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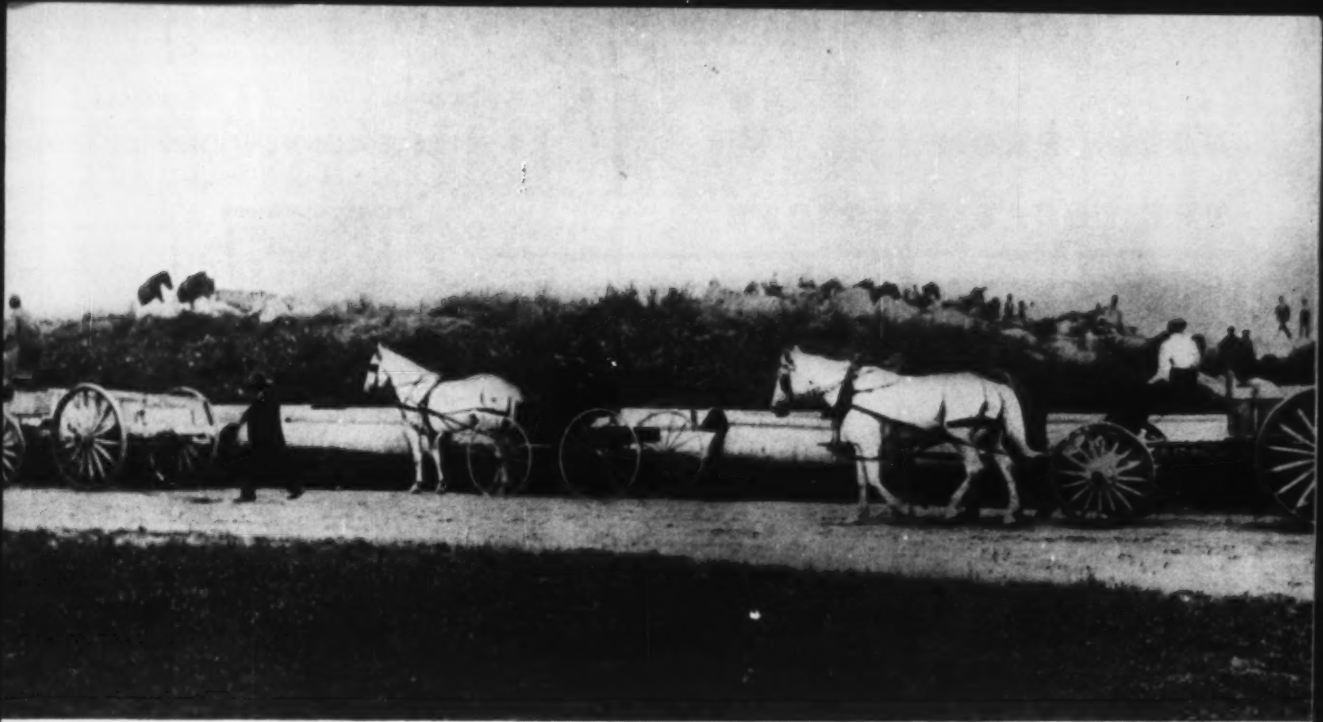
Donald Kowtko 289 Foxhill Road Denville, N. J.	Albert C. Nelson 250 N.E. 51st Street Miami, Fla.	William R. Walker 4600 Franklin Ave. Western Springs, Ill.	Judd Hull 6000 S. Boyle Ave. Vernon, Calif.



1896-laying New Bedford's 48-in. steel main

(and it's still in service!)

The quaint scene shown here occurred during installation of eight miles of 48-in. ID riveted steel pipe in New Bedford, Massachusetts, in 1896. Pipe-laying methods were primitive, by present-day standards, but even then steel was a preferred material for transmission mains.

The Water Department reports that there has never been a failure in over sixty years of operation. In fact, they expect the line to remain in service for many years to come.

So it is throughout the country: water departments report steel pipe in service after thirty, forty, fifty or more years. We'll gladly document this statement on request.

Because of today's vastly superior grades of steel, fabricating methods, and coating materials, many engineers conservatively estimate steel pipe's life expectancy as fifty years minimum, and most likely upwards of a century.

Add *long life* to steel's unequalled strength, high flow capacity, and leakproof qualities, and you can see why tar-enameled steel pipe is the logical material for water mains. For more information, simply get in touch with the Bethlehem sales office nearest you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Sales: Bethlehem Steel Export Corporation

Much of the line lies in swampy terrain. Yet the pipe has never failed, although its only protection was a tar-dip.

See Bethlehem's exhibit on three of the "Top Ten Plants of 1960" at the Industrial Building Exposition and Congress, December 12-15, in the New York Coliseum.

BETHLEHEM STEEL

BETHLEHEM STEEL

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the fifth of the month preceding date of publication)

A recent meeting of the **Akron Section** decided to have a clean-up drive in October for funds for the United Engineering Center. Philip Doane then spoke on the Akron Council of Engineering and Scientific Societies (ACESS) and asked that the Section's membership support the organization. A step in that direction was the appointments of James Sloan and William Weichl to handle the ASCE portion of the ACESS Vocational Guidance program for the area grade schools and high schools.

A recent issue of the **Illinois Section's** *ASCE News* carried an item by its president, John G. Hendrickson, Jr., in which he deplored the drop in the registration of civil engineering students to a point where some private schools on limited budgets have considered dropping civil engineering from their under-graduate curriculum. President Hendrickson comes up with some good answers to the question, "Why be a civil engineer?" He says, "Although civil engineering does not have the glamour of jet aircraft, electronics, or the field of plastics . . . more than any other field of engineering it contributes to the public welfare. The health of the community, its economic welfare are all to a degree dependent on the services of the civil engineer." Off to a good start is the Section's new Soil Mechanics and Foundations Group. The group plans to meet every month.

The new officers of the **Metropolitan Section** were presented to the membership at the recent first meeting of the fiscal year. Robert H. Dodds is the new president; Gardner M. Reynolds and Malcolm Pirnie, Jr., vice presidents; Brother B. Austin Barry, secretary; and William J. Shea, treasurer. Elected directors were Milton Alpern, Barclay G. Johnson, William J. Mulder, Raymond L. Brandes, Joseph M. DeSalvo, and Frederick S. Merritt.

A recent interesting talk by Dewey M. McCain, professor and head of the de-

(Continued on page 86)

At the October meeting in Boston the Board of Direction approved formation of a new Northeastern Indiana Branch of the Indiana Section. Shown at a recent organizational meeting in Fort Wayne are (left to right) J. I. Perrey, chairman of the District 9 Council; J. Hnot, president of the Indiana Section, receiving the petition to establish the Branch; Lawrence Volz, temporary chairman of the Branch, presenting the petition; and Donald Ort, organizational chairman.

AMERICAN
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ENGINEERS
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1852

ASCE CONVENTIONS

PHOENIX CONVENTION
Phoenix, Ariz.
Hotel Westward Ho
April 10-14, 1961

ANNUAL CONVENTION
New York, N. Y.
Hotel Statler
October 16-20, 1961

HOUSTON CONVENTION
Houston, Tex.
Hotel Shamrock
February 19-23, 1962

TECHNICAL DIVISION MEETINGS

AIR TRANSPORT CONFERENCE
Miami, Fla.
May 11 and 12, 1961

Sponsored by
Air Transport Division
Airport Operators Council

DISTRICT CONFERENCES

DISTRICT 3 COUNCIL
Syracuse, N. Y.
Airways Inn
November 19, 1960

LOCAL SECTION MEETINGS

Georgia—Annual meeting at the Architects and Engineers Institute on December 3, followed by a dinner meeting at the Biltmore Hotel in the Pompeian Room.

Metropolitan—Regular monthly meetings in the Engineering Societies Building on the third Wednesday of each month, at 7:00 p.m.

Mid-South—Annual Spring meeting in Vicksburg, Miss., April 27-29. Host for the occasion is the Vicksburg Branch.

Philadelphia—Joint meeting with the American Society of Mechanical Engineers at the Engineers' Club on December 13, at 7.30 p.m.

Sacramento—Weekly meetings at the Elks Temple every Tuesday, at 12 noon.

San Francisco—Dinner meeting of the Construction Division at the Montclair Restaurant, San Francisco, on November 17.

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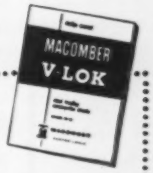

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Winners of the Student Paper Contest, held annually at Northwestern University under the auspices of the Illinois Section, are (left to right) David Guell, who received the first place prize of $50 for his paper "The Role of Electronic Computers in Bridge Design"; Howard Almgren, third place prize winner ($20) for "Shore Protection"; and David Boyce, second place prize winner ($30) for "Urban Renewal—The Challenge in Expressway Location." In addition to the cash awards, each received a copy of the Centennial Transactions.

partment of civil engineering at the Mississippi State University, before the **Jackson Branch** of the **Mid-South Section** stressed that the practicing professional engineer cannot sit idly by and depend on teachers alone to establish the educational foundation which will determine the type of men they employ and the type of engineer which will be produced for the future. The topic, "Eggheads and Engineering Education—A Challenge to the Practicing Engineer," also stressed the importance of accreditation in maintaining high standards of engineering education in our colleges, and deplored the lack of graduate schools for engineers. Before the meeting adjourned William H. Robinson was elected president for the coming year; Henry G. Howard, vice president; and B. K. Melton, secretary-treasurer. The three directors are John M. Dempsey (for two years), James D. Schell (for two years) and Frank Redus, Jr., (for one year).

In keeping with the intent of the Collier-Burns Highway Act of 1947, a recent resolution of the **Sacramento Section** urged registration for road commissioners. It proposed increasing the Highway Users Tax Fund apportionment for engineering and administration in counties employing a registered civil engineer as road commissioner or principal engineering assistant. Evidence of the present ineffectiveness of the Highway Act is that less than one-third of the 24 counties within the area encompassed by the Section employ registered civil engineers as road commissioners. Means for implementing the resolution are being studied by a committee headed by William A. White and consisting of James K. Carr, Harold L. Joynes, and Robin R. Reynolds.

According to Paul Siebert, of the Seattle Central Association, and John Spaeth, director of planning, City of Seattle—guest speakers at the September meeting of the **Seattle Section**—a comprehensive plan for downtown development has been prepared for the first time in Seattle's history. Messrs. Siebert and Spaeth pointed out that while primary responsibility rests with the Central Association and the City Planning Commission it also involves every local governmental agency, as well as private interests. The plan will provide a workable guide for future public projects to assure that public funds are most wisely spent.

Eric C. Molke, of Summers, Munninger and Molke, Albany, N. Y., discussed his design for the Oneida Lake Bridge at the September 20 luncheon meeting of the **Syracuse Section.** After lunch the Section made an inspection tour of the bridge, which has the longest prestressed concrete span in the Western Hemisphere, and is being built at a cost of $1,700,000.

The **Texas Section** presented Andrew Peach Rollins with this year's Award of Honor at its fall meeting held in Dallas, Tex., on September 30. The ninth civil engineer to receive this award, Mr. Rollins has served as general manager of the North Texas Municipal Water District at Wylie for the past five years. He has also served as chairman of the Texas State Board of Water Engineers and as Director of Public Works. The Section's **Dallas Branch** has elected new officers for the forthcoming Section year. Fred Adams takes over as president; Elmer Nooner as vice president; and Banks McLaurin as secretary-treasurer. Clare Colman and Joe Nall are senior director and associate director.

The West Virginia Section's annual meeting was held jointly with the West Virginia Society of Professional Engineers at the Greenbrier Hotel, White Sulphur Springs, W. Va., September 22 and 23. Pictured at the head table on banquet night are (left to right) Lowell Hetzel; Otis D. Gouty, Assistant to the Secretary at ASCE Headquarters; William Foster, editor of "American City;" Mrs. Earle T. Andrews; Earle T. Andrews, then ASCE Director-elect for District 6 and president of the West Virginia Society of Professional Engineers; Mrs. A. S. Cappellari; A. S. Cappellari, president of the West Virginia Section; Mrs. Paul H. Robbins; Paul H. Robbins, executive director of the National Society of Professional Engineers; and Tilton E. Shelburne, then ASCE Director for District 6. Guest speaker for the occasion was Mr. Foster.

BY-LINE WASHINGTON . . . . .

Pollution—and what to do about it—took top spot in a Washington that had settled itself into political doldrums pending the arrival of a new President and a new Congress in January. In most cases, engineering solutions would be called for or affected. Here are some of the developments:

As expected (September column, page 90), the Department of Justice has filed suit against the City of St. Joseph, Mo., for failure to comply with orders to clean up its sewage discharges into the Missouri River. As expected, also, the suit appeared to name all city residents, as well as officials and employees, as defendants. An injunction favoring the government would put real teeth into stream cleanup attempts, but how it would be enforced against 78,000 persons is another matter.

The U.S. Public Health Service—under heavy pressure from Congress—has begun staffing its Chicago offices for a $500,000 survey of pollution in Lake Michigan. Officially, the work is the start of a $12 million, six-year program that will include all the Great Lakes. But Congress is "very anxious" to have a report on Lake Michigan before it again takes up the question of additional diversion from the lake sought by the Chicago Sanitary District. A Supreme Court case on the same subject may also be affected.

On a review of actions during the past several months, it is certain that there will be some revision of the status of federal pollution control agencies—and the dispute is basically over whether pollution control is an engineering or a medical problem. The Eisenhower administration has proposed that existing divisions of water pollution, air pollution, radiation and industrial hygiene be raised to Bureau status within the Department of Health, Education and Welfare. Congressman John A. Blatnik, author of existing pollution control legislation, wants to establish the work as an independent agency, with its own administrator and budget. He is backing the engineers over the medical men in this area.

* * *

A new source of construction funds—for work far beyond housing—may emerge out of changes in the tax laws which now permit formation of "Real Estate Investment Trusts," exempt from corporate income taxes if they distribute 90 percent of their profits to investors. Conceived as an aid to housing, the new law has attracted the attention of several hotel corporations, and tax specialists think provisions might cover construction of offices, factories, and other structures as well as housing.

* * *

A cement price rise seems inevitable next year, under an amendment to tax laws that will require manufacturers in 1961 to take depletion allowances on "kiln feed" (value of calcium carbonates and silicas at the point of feed to the kiln) rather than on finished cement. The law follows closely a Supreme Court decision involving a clay pipe manufacturer, in which the court said that the depletion allowance must be applied to the value of the clay, not the finished product.

Engineers will want to keep a close eye on the new International Development Association (IDA), which has just come into being to finance economic growth in less developed countries. An affiliate of the World Bank, IDA will make loans on somewhat easier terms than its "big brother," out of an initial capital subscription of $1 billion. Actually, IDA will not start functioning until late this fall, when a first directors' meeting will be held. Meanwhile, it has its headquarters at World Bank offices, 1818 H Street, N.W., Washington 25, D.C.

* * *

You can look for fighting next year on proposals to levy tolls on waterways operators. The operators themselves have reactivated their "National Waterways Conference" to fight proposals for tolls with publicity and in Congressional committees. The reason for their action is the very well founded story that a special Senate committee study on U.S. transportation will present a recommendation for tolls—to repay the government for the roughly $2.4 billion spent on waterways and for proposed expenditures that might run to $7.9 million more over the next three decades.

The action of the waterways operators is somewhat similar to what highway-user and builders' organizations have been doing, through their own newly organized Better Highways Information Foundation, based in Washington. At a recent session, BHIF directors voted a $220,000 fund to finance public relations activities of the organization for a year—in addition to funds already committed for operation, staff and other purposes.

* * *

The Navy is showing real interest in a possible new use for those sections of floating drydocks that have been mothballed since the end of World War II. Suggested use—with the addition of "legs" in the manner of the Texas Towers—is as mobile missile launching platforms, or platforms to mount tracking and telemetry equipment. It has been estimated that, at a cost of about $1 million (including the legs and refurbishing), the drydock sections could be put in service. The advantage would be that the launchers could be stationed anywhere in the open ocean, without necessity of international treaties, and would be tough targets for an enemy because they could be moved at will.

* * *

Working under a $1 million contract, a joint-venture of five consulting firms is now preparing what may be a complete revision and updating of the Bureau of Yards and Docks' engineering design criteria manuals. The joint venture includes Hazen & Sawyer; Eggers & Higgins; Moran, Proctor, Meuser and Rutledge; Praeger-Kavanaugh, and Syska & Hennessy. Its headquarters are in Hazen & Sawyer's New York offices. The Bureau's own engineering staff is working with the group, hopes to bring out revisions of various sections of the manuals (a total of some 25 volumes are involved) as they are prepared.

Steel reinforced ...to stand up

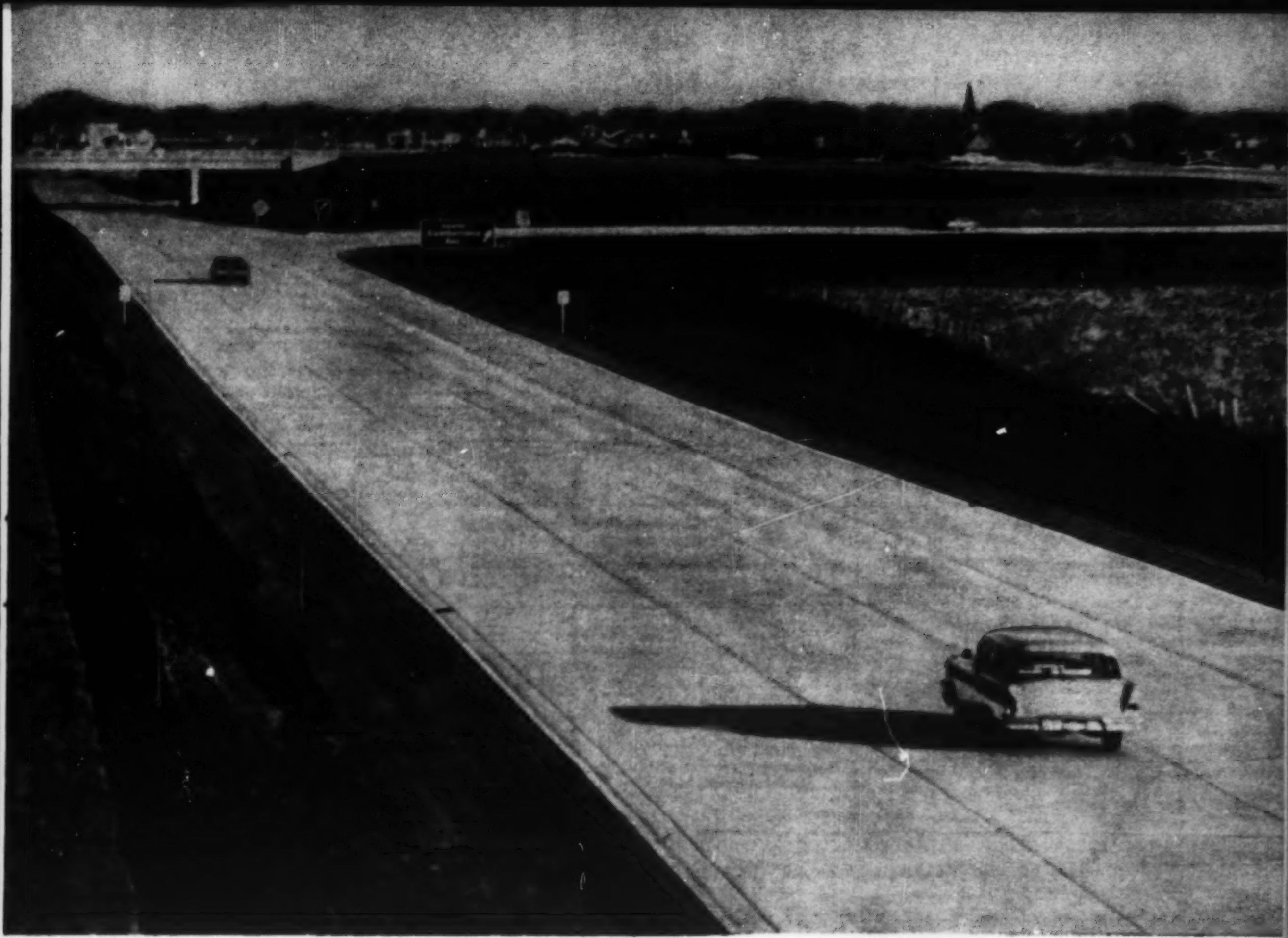
PROJECT: Portion of Northwest Expressway just west of Cumberland Avenue Interchange, Cook County, Illinois

OWNER: Cook County Department of Highways

CONTRACTORS: Arcole Midwest Corp., Evanston, Illinois

WIRE FABRIC DISTRIBUTOR: E. W. Zimmerman, Inc., Chicago, Illinois

This mark tells you
a product is made of modern,
dependable Steel.



under the hi-speed pounding of modern traffic

Cook County, Illinois has opened the first section of its new Northwest Expressway. And, like other expressways built under the authority and supervision of that county's Department of Highways, it is steel reinforced.

An anticipated daily count of 31,000 vehicles is expected on this newly opened 4½-mile section which extends from Foster & Central Avenues to the Illinois Toll Highway. This figure indicates what this already busy strip will be subjected to as the traffic load gets heavier. And it points up the importance of building into all new roads and highways the strength it will take to stand up under the almost ceaseless pounding of modern hi-speed traffic in the years ahead.

Highways reinforced with steel have a balanced design in that all edges and corners are fully protected. USS American Welded Wire Fabric accomplishes distributed load transfer and reduces stresses about 30% which accounts for the truly superior performance of reinforced concrete over non-reinforced concrete. Reinforced pavements provide a safe, smooth riding surface that lasts.

USS American Welded Wire Fabric is today stronger than ever. Minimum tensile strength is now 75,000 psi and minimum yield point is now 60,000 psi. It has reserve strength for heavier pounding and it is available in a completely machine fabricated form, ready for immediate placement. For more information, write to American Steel & Wire, 614 Superior Avenue, N. W., Cleveland 13, Ohio. *USS and American are registered trademarks*

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News Briefs . . .

Picture of Construction Spending in September

The total value of new construction put in place this past September amounted to $5.3 billion, according to preliminary estimates of the Bureau of the Census of the U.S. Department of Commerce. The seasonally adjusted annual rate of new construction for the month was $55.4 billion—1 percent more than the equivalent annual rate in August and about the same level as in September 1959. The value of new construction expenditures in the first nine months of 1960 was $40.8 billion—3 percent less than the total for the first nine months of 1959.

The Bureau of the Census notes that, in making comparisons with data for 1959, it should be remembered that the estimates for September 1959 reflect the effects of steel shortages resulting from the steel strike. Results of a special survey to determine any possible effects of steel shortages on construction work were applied to the figures derived from normal estimating procedures.

Total new private construction expenditures this September amounted to $3.6 billion—about the same as in August but 4 percent under the September 1959 level. Spending for private residential building amounted to $2.0 billion, 1 percent less than in August and 13 percent less than in last September. For the first nine months of 1960, the cumulative value of private expenditures was $29.0 billion, compared to $29.5 billion in the same period of 1959, and the cumulative value of private residential expenditures was $16.5 billion, 9 percent less than in the comparable period of 1959.

Total public construction expenditures this September amounted to $1.7 billion, 3 percent more than in August and 9 percent above September 1959. However, the cumulative value of public construction for the first nine months was $11.8 billion—5 percent below the total for the first nine months of 1959.

Water Pollution Control Federation Has Annual Meeting

Meeting for the first time under its new name, the Water Pollution Control Federation highlighted 33 years of progress in water-pollution control at its four-day annual meeting in Philadelphia, October 2-6.

A feature of the meeting was the election of Ray E. Lawrence, F. ASCE, to the presidency of the Federation. A partner in the Kansas City, Mo., consulting firm of Black and Veatch, Mr. Lawrence brings to his new office a wealth of experience in the waste water field. Another Fellow of ASCE, Harry E. Schlenz, president of the Pacific Flush Tank Co. of Chicago, was elected vice president of the WPCF. Mr. Schlenz is a member of the Steering Committee of President Eisenhower's National Conference on Water Pollution.

Some 1,500 experts gathered at Convention Hall during the meeting to hear technical papers and to review exhibits set up by over 55 manufacturers of equipment and supplies for the waste water field.

A subject frequently discussed both formally in a four-paper session and informally in the corridors was that of public relations. C. F. Wertz, F. ASCE, president of the American Water Works Association and director of the Miami Department of Water and Sewers, described good public relations as good business management. He stated that the most important aspect of public relations—after a good job has been done—is keeping the public informed. A good utility must command respect—it cannot demand it! Employees are the first line of communication to the public, and it pays to inform all employees of the benefits of good public relations.

R. E. Lawrence

H. E. Schlenz

J. E. Meers, superintendent of the Sanitary District of Bloom Township in Chicago Heights, Ill., told the public relations session that a well-informed and interested public will approve needed projects more readily than an uninformed group. As a case in point, he described a situation in the Chicago area where a $1,630,000 bond issue for improvements to a sewage treatment plant was defeated by a 4-to-1 majority in 1952. Eighteen months later, after an extensive program of informing the public, the voters passed the same bond issue for $1,750,000.

Along these same lines, the Water Pollution Control Federation, recognizing the importance of good public relations, now has a full-time public relations man on its staff.

Among the thirteen sessions, at which over fifty technical papers were presented, were four devoted to various phases of control of polluted streams contaminated by industrial wastes. At one of these sessions three papers were presented on the cooperation in pollution control between industry and the Ohio River Valley Water Sanitation Commission, an active interstate group for water pollution control. It was pointed out that eight states reconciled their view and reached common agreement to take on a job in water pollution control that none alone could do. In addition several industry action groups have been established to advise and assist the Commission. The Commission has adopted control measures where compliance is voluntary, and fortunately industry in general has accepted such measures as requirements to be met.

Other technical sessions were devoted to design, operation, and maintenance of treatment plants; waste water collection and treatment; microbiology; and biological treatment and research.

During the meeting Renville S. Rankin, F. ASCE was awarded a posthumous honorary membership in the Federation. Mr. Rankin's death, on June 6, 1960, ended a 47-year career devoted to the advancement of sanitary engineering practice in the United States and abroad. At the time of his death he was serving as secretary of the American Sanitary Engineering Intersociety Board.

Ford Foundation Gives Money for Astrograph

An astrograph—a telescope for precisely measuring the motion of stars in our galaxy—will be built in the Southern Hemisphere with a $750,000 grant recently announced by the Ford Foundation. The new star camera will fill a gap, consisting of one-third of the sky, in which the position and speed of stars cannot now be measured with great precision. The only such existing astrograph, located at the Lick Observatory, Mt. Hamilton, Calif., covers only two-thirds of the sky. The two instruments together will permit accurate measurement of stellar motion throughout the galaxy.

The grant was made to Yale University, which will operate the Southern Hemisphere astrograph jointly with Columbia University.

AISC Honors Beautiful Steel Bridges Opened in 1959

Fifteen steel bridges have been chosen as the most beautiful opened to traffic in the United States during 1959. The prize-winning structures were selected in the annual competition sponsored by the American Institute of Steel Construction, a national association representing the fabricated structural steel industry. The number of entries received this year was the largest in the 32-year history of the competition.

In special ceremonies to be arranged at the sites later this year, stainless steel plaques will be affixed to the three top winners: **Class I** (for bridges with spans of 400 ft or more), the Glen Canyon Bridge at Page, Ariz.; **Class II** (for bridges with fixed spans under 400 ft and costing more than $500,000), the Huasna River Bridge at Santa Maria, Calif.; and **Class III** (for bridges with spans under 400 ft, costing less than $500,000), the Modrow Bridge in Cowlitz County, Washington. There was no award in Class IV, for bridges with movable spans.

The plaque-winning bridges are pictured here.

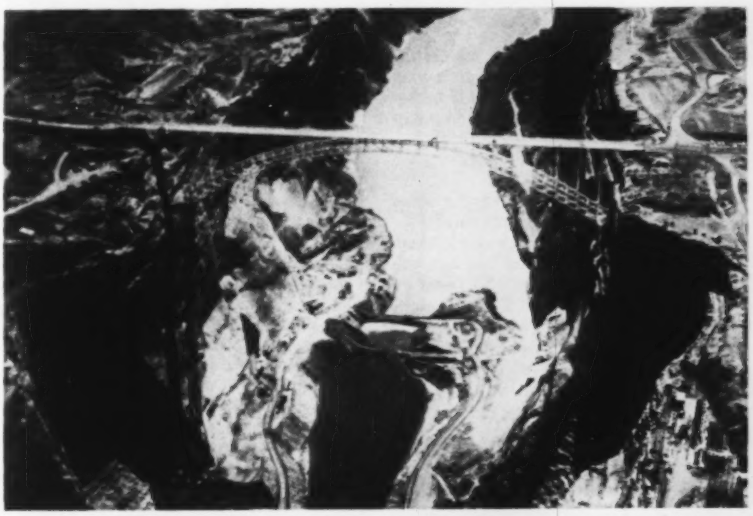
Certificates of honorable mention will be awarded to the designers, owners, and structural steel fabricators of the following bridges:

Class I: American Rapids Bridge (Niagara Falls, N. Y.), designed by Praeger & Kavanagh; Fort Pitt Bridge (Pittsburgh, Pa.), designed by Richardson, Gordon and Associates; and Interstate Route 502 over the Mohawk River (Colonie, N. Y.), designed by Office of Deputy Chief Engineer (Bridges), N. Y. State Department of Public Works, assisted by Frankland & Lienhart.

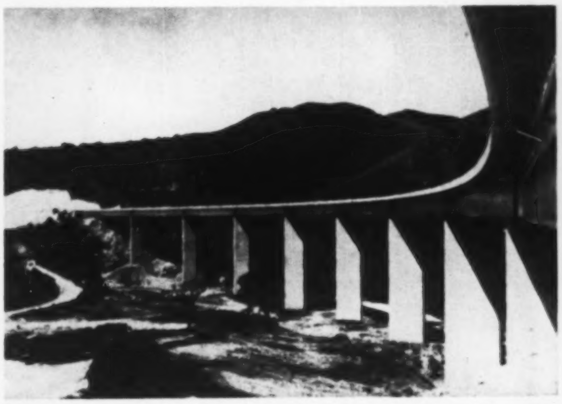
Class II: College Avenue Bridge (Appleton, Wis.), designed by the Bridge Section of the Wisconsin State Highway Commission; Robert Shoemaker Bridge (Long Beach, Calif.), designed by Moffatt & Nichol; Pennsylvania Boulevard Bridge (over the Schuylkill River), designed by Gannett Fleming Corddry & Carpenter; the P. R. Olgiati Bridge (Chattanooga, Tenn.), designed by Aake F. Hedman & Associates; and the Park Road Bridge (Washington, D. C.), designed by the D. C. Department of Highways and Traffic.

Class III: Truckee River Bridge (Truckee, Calif.), designed by the California Department of Public Works; Pecos River Bridge (Ft. Sumner, N. Mex.), designed by the Bridge Design Section, New Mexico State Highway Department; and Kern Avenue Pedestrian Overcrossing (McFarland, Calif.), designed by the California Department of Public Works.

Class IV: Grant Line Canal Bridge (between Stockton and Tracy, Calif.), designed by the California Department of Public Works.



Glen Canyon Bridge over the Colorado River at Page, Ariz., is the winner in Class I. The designer was the U. S. Bureau of Reclamation, and the fabricator the Judson-Pacific-Murphy Corporation. The jury praised the "elegant, airy arch design that contrasts so beautifully with the grand brutality of the setting."



Huasna River Bridge, near Santa Maria, Calif., is winner in Class II. The designer was the California Department of Public Works, and the fabricator Vinnell Steel (Irwindale, Calif.) The design was cited as utilizing "simple form to obtain an overall pleasing effect."

Modrow Bridge, in Cowlitz County, Washington, winner in Class III, was designed by Harry R. Powell & Associates, Seattle, Wash., and fabricated by the Isaacson Iron Works. It was cited as "the most imaginative and sensitive bridge in the competition."

Prestressed Concrete Institute Meets in New York

Engineers attending the Sixth Annual Convention of the Prestressed Concrete Institute, held at the Statler-Hilton Hotel in New York City early in October, heard John M. Kyle, F. ASCE, chief engineer of the Port of New York Authority, say that prestressed concrete techniques have been used on every facet of the Port Authority's construction program. He also said that where prestressing has been used to replace conventional construction, the development of newer techniques and design theories applied to the conventional construction has resulted in lower costs. However, he continued, where specialized problems are encountered, prestressing has very often proved to be the only valid solution.

Mr. Kyle challenged the prestressing industry to develop new and different uses for the product, to improve the technology of the art from both a design and construction standpoint, and to make every effort to do away with any artificial barriers which result from outmoded practices or regulations. All this is necessary, he said, if the prestressed industry is to go forward.

European practice

One of the nine sessions at the four-day meeting was devoted to a symposium on prestressed concrete pavements. Prof. Daniel C. C. Vandepitte, of the University of Ghent in Belgium, told a capacity audience that most of the work done to date in prestressed concrete pavements has been experimental and the number of actual pavements is still very small. He stated that the prestressed pavements are of two types: (1) those prestressed in two directions by means of tensioned steel, and (2) those prestressed by tensioned steel in the direction of their width only or not prestressed in that direction and prestressed in the other direction by means of jacks, with thrust blocks to withstand the prestressing forces in the latter direction at the ends of the pavement.

Experimental slabs of the first type with various tendon arrangements have been built in several countries. Due to subgrade restraint, there is an upper limit to the distance apart of the free edges. Hence prestressing reduces the number of joints, but does not eliminate them. The stress variations induced by weather changes are relatively slight. This type is suitable for pavements of limited length, hard-standings for example.

Pavements of the second type have no mobile joints. There is no upper limit to their length. The stress variations in the longitudinal direction due to weather changes are great. Pavements of this type require abutments and are economical only when they are long enough. They are suitable for runways and roads.

The most important pavements of the second type built to date are the runways at the Algiers and Brussels airports. The former has abutments consisting of curved concrete slabs loaded with earth, and the connections between them and the prestressed slab are made elastic, lest the thrust exerted on the abutments vary too much with weather changes. Except for the abutments, the runway at the Brussels Airport differs little from the one at Algiers. The prestressed slab pushes directly against the abutments, which consequently have to withstand the highest thrust occurring in the slab in hot and humid weather.

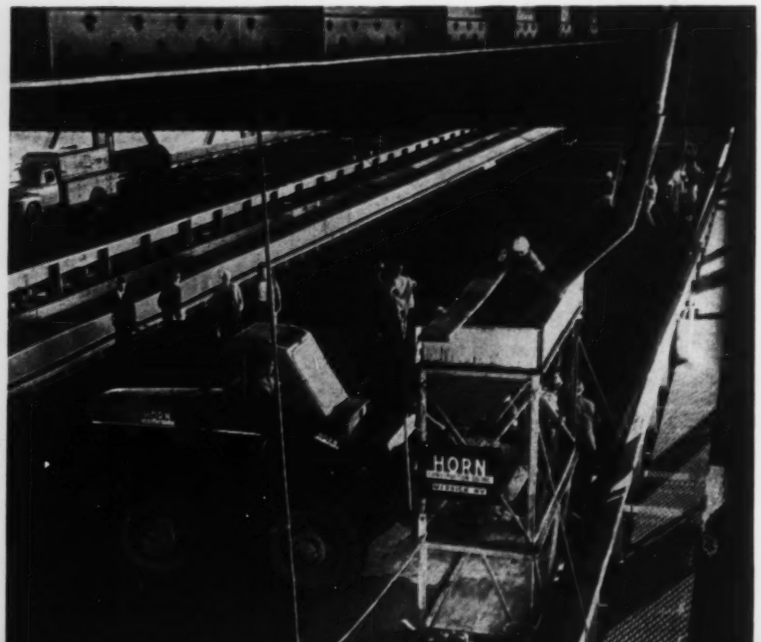
Dr. Lev Zetlin, M. ASCE, consulting engineer of New York City, described a unique American concept of pretensioning in prestressed concrete pavements. He said that instead of pretensioning strands by common heavy abutments anchored to the ground, a portable abutment, which was devised for the U.S. Navy, could be used. The portable abutment makes it possible to construct a continuous pavement prestressed in two directions—the length of the pavement between joints may be as long as 1,200 ft. The portable abutment permits the use of conventional paving equipment.

Because of the possibility of continuous reuse of the portable abutment in mass construction and the relatively simple construction operations, prestressed highways are within the realm of economical possibility. The portable abutment could also be used for two-way prestressing of slabs of any shape in prestressing plants.

Jacob Whitlock to head PCI

A highlight of the PCI Convention was the election of Jacob O. Whitlock, president of Midwest Prestressed Concrete Co., Springfield, Ill., to the presidency of the Prestressed Concrete Institute. Elected as vice president for the coming year was Robert J. Lyman, F. ASCE, of the Atlas Structural Concrete, Inc. at El Paso, Tex. Robert A. Matthew, of Precast Industries, Inc., Kalamazoo, Mich., was named treasurer.

Concreting Starts for Lower Deck of George Washington Bridge



About 5,000 cu yd of lightweight concrete will be placed to a depth of 4½ in. in I-beam grid for the lower deck of the George Washington Bridge between New York and New Jersey. Concrete is delivered by transit-mix trucks through 2-ft-square holes cut in the sidewalks of the upper deck. Hoppers on the lower deck discharge to a "payloader" that distributes the concrete. Wearing surface will be 1½ in. of asphaltic material. The Port of New York Authority estimates it will take five weeks to complete the lower deck paving. The entire facility will be open to traffic in 1962 when the approaches are completed

New Type of Median Barrier for California Freeway

Erection of 13,000 lin ft of a new type of highway median barrier—the product of the Cyclone Fence Department of the U.S. Steel Corporation—has just been completed on the Golden State Freeway at Los Angeles. Called "Flexigard," the median barrier combines the strength and resiliency of three wire rope cables and chain link steel fabric strung on steel H-column line posts, set 8 ft apart and centered in the 16-ft divider of the four-lane freeway. The mesh acts as a resilient trapping device to keep speeding vehicles from crossing the median strip into oncoming traffic. The steel cables will tend to keep cars from overturning or swerving into their original traffic stream. Erection of the fence was completed in 30 days, following full-scale dynamic tests of barrier designs by the Materials and Research Department of the California State Division of Highways. Officials expect it will reduce the frequency of head-on collisions on divided high-speed expressways.

NORTH
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Publications From Urban Renewal Administration

The Urban Renewal Administration in establishing its new comprehensive publications program has announced that three new series of publications will be issued periodically:

- Urban Renewal Notes
- Technical Guides
- Urban Renewal Bulletins

Urban Renewal Notes, a bi-monthly digest or index to experience, is designed to serve all audiences actively interested in urban renewal. Included will be brief descriptions of good techniques and local approaches and success, as well as pertinent URA program developments and publications. Items will be kept brief with the source given at the end of each article.

Technical Guides will be a technical series, reporting advice and recommended procedure. Primarily intended for the professional, administrative and technical staff of all levels of government, consultants and others actively engaged in urban renewal, Technical Guides will supplement URA program requirements.

Urban Renewal Bulletins will be directed mainly at the nonprofessional concerned with or involved in urban renewals. They will be nontechnical, designed to provide a means for interested persons to learn how the urban renewal process can work for the individual and his community.

Technical Guides and Urban Renewal Bulletins will be available for a nominal fee from the Superintendent of Documents, Washington 25, D. C. Local public agencies will receive a limited number free. Urban Renewal Notes are available free from the Urban Renewal Administration, Washington 25, D. C.

Competition for Student Papers on Welded Design

Opening of its 1960-1961 engineering undergraduate award program is announced by the James F. Lincoln Arc Welding Foundation. This year's competition, the fourteenth in an annual series, offers awards for papers on welded design in each of two non-competing divisions of the program—Machines and Structures. The top award in each division is $1,500, ranging downward to ten sixth-place awards of $50. Only resident, undergraduate engineering students are eligible to submit papers.

Rules for the new competition incorporate a number of changes from previous years. A booklet describing the 1960-1961 program may be obtained from the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. Closing date for the competition is June 26, 1961.

Contract Awarded for Century City Planning

Award of a contract to Daniel, Mann, Johnson & Mendenhall for an engineering and planning report for Century City has been announced by Frederick J. Gebers, general manager of the huge commercial-residential development in Los Angeles. Under the agreement, the Los Angeles firm of architects, engineers, and planners will make studies and recommendations on proposed streets, utilities, drainage, and grading needed for proper utilization of the 260-acre site immediately west of Beverly Hills.

The Century City land is being purchased from 20th Century-Fox Film Corporation by Webb & Knapp, New York real estate company, and the Aluminum Company of America. Construction of the first units—including a regional shopping center and several office and apartment buildings—is scheduled to start next spring.

Century City will ultimately represent more than $250,000,000 worth of buildings and will be the largest privately financed urban development in the United States.

TVA Issues Volume on Design of Hydro Plants

"Mechanical Design of Hydro Plants," the third and final volume of the Tennessee Valley Authority's Technical Report No. 24, *Design of TVA Projects*, is a good buy at $3.75. The wide scope of Volume 3 is indicated by the fact that it explains all the engineering work involved in the design of mechanical installations for the primary water control structures of TVA and the related improvements in the reservoir areas. It contains 986 pages and 368 illustrations.

Engineers and constructors engaged in hydroelectric work should find the three-part series extremely useful. Volume 1, "Civil and Structural Design," was published in 1952, and Volume 2, "Electrical Design of Hydro Plants," was issued in 1954.

Other engineering reports of the TVA include a series of fourteen volumes on major dam and reservoir projects, two volumes on steam plants, and six manuals on special subjects. All but the Norris, Wheeler, and Pickwick Landing project reports are currently available from the TVA Treasurer's Office, Knoxville, Tenn.

Use of High-Strength Bolts Speeds Bridge Project

Changing erection plans in mid-stream, the Bethlehem Steel Co. will complete the partially constructed Chicago, Burlington & Quincy Railroad Bridge in Quincy, Ill., using high-strength bolts instead of field rivets. About 140,000 bolts will be required to complete the final two-thirds of the 2,500-ft-long bridge, the first major crossing to be high-strength bolted. The decision to use bolts was influenced by the impossibility of obtaining enough experienced riveting crews to finish the project by the end of the year as scheduled. The bridge is made up of six girder and eight truss spans. Two shorter structures—a 716-ft Quincy Bay Bridge (seven girder spans) and a 296-ft State Aid Route No. 7 bridge (three girder spans) are also part of the 4½-mile-long line change. Howard, Needles, Tammen and Bergendoff are the consulting engineers on the project.

AGC Foresees Normal Construction Year

The outlook for construction activity in the next few months is about normal for the time of year, according to a report of the nation's construction leaders presented at the mid-year meeting of the Governing and Advisory Board of the Associated General Contractors of America at Phoenix, Ariz., October 2-6. It is the expectation of the group of experts that the total volume of new construction put in place in 1960 will be close to the all-time-high dollar value of 1959 construction, which was $56.1 billion.

The highway directors' session emphasized the need for better public understanding and support of the expanded highway construction program. This was the substance of a talk by Erskine Stewart of Washington, D.C., vice president of the Better Highways Information Foundation, as well as of comments by highway contractors and AGC chapter managers. It was pointed out that Congress will enact new legislation concerning the highway program next year and that some forces are at work to delay or reduce the program.

AGC officers for 1961 were nominated during the closing session. M. Clare Miller, current vice president of AGC and highway contractor of McPherson, Kans., was nominated for president, and Frank F. Burrows, building contractor of Belmont, Calif., is the nominee for vice president. The election will be conducted by letter ballot in December, and the installation of new officers will take place at the 1961 AGC convention in Boston, February 27-March 2.

ASTM Selects New Executive Secretary

Thomas A. Marshall, Jr., until recently senior assistant secretary of the American Society of Mechanical Engineers, has been elected executive secretary of the American Society for Testing Materials by its Board of Directors, and took office on October 15. In his new post Mr. Marshall heads the staff for the 16,500-member society.

Fred F. Van Atta, F. ASCE, formerly assistant secretary of the ASTM, has been elected to the post of treasurer, with responsibility for the business operations of the society. Robert J. Painter, formerly executive secretary and treasurer, will continue as consultant to the executive secretary. He will be especially concerned with the society's long-range planning program. Raymond E. Hess, M. ASCE, will continue as associate executive secretary. As technical secretary and editor-in-chief, Mr. Hess is responsible for the technical activities and publications of the ASTM.

APWA Receives Ford Foundation Grant

The Ford Foundation has approved a grant of $40,000 to the American Public Works Association for an exploratory study of research problems and priorities in the public works field. In spite of the tremendous sums of money currently expended on public works, the APWA notes, "there is an appalling lack of research being carried on to find better ways and means of providing needed facilities and services." The present one-year study will be conducted by a project director and a select group of consultants representing various fields of allied interest.

Samuel Baxter, Director of ASCE and commissioner of the Philadelphia Water Department, is chairman of the APWA Research Foundation's Board of Trustees.

Atomic Power Plant for Carolinas-Virginia Group

Ground has been broken at Parr, S. C., for the first atomic power project in the Southeast. The ceremony marked the beginning of construction of the 17,000-kw generating station of Carolinas-Virginia Nuclear Power Associates, Inc.—a utility group made up of the Duke Power Company, the South Carolina Electric and Gas Company, the Carolina Power and Light Company, and the Virginia Electric and Power Company. The plant will be completed in mid-1962.

Westinghouse Electric Corporation's atomic power division is responsible for development and design of the reactor plant and is furnishing equipment for it. The Stone & Webster Engineering Corporation is the architect-engineer.

The utilities will have an investment of about $28 million in capital and other costs in the project. The cost to the U. S. Atomic Energy Commission, for research, development and other charges, will be about $15 million.

The atomic power project at Parr represents the first time that private companies have invested in a reactor that will use heavy water both as a coolant and moderator. Until now, most commercial atomic reactors have used ordinary water as the moderator. The new reactor will also eliminate the large pressure vessel, which has been a basic component of previous pressurized water reactors. Instead it will have pressure tubes installed in a relatively simple and low-pressure tank. Greater flexibility of operation is expected to result from this change.

EXAM GEMS

by Reggie Strashun

R. ROBINSON ROWE, F. ASCE

EXAMGEM No. 16: A 3 × 12 S4S plank is suspended between two supports and used by two men removing bottom forms from a concrete slab. Each man weighs 170 lb and may carry up to 60 lb as they walk the plank, independently except that the distance between them is never less than 2.5 ft. Limiting flexural stress to 1000 psi, determine the allowable distance between supports.

The text has been repeated verbatim to emphasize what was said and what was *not* said. Men ready for registration considered the weight of the plank and the impact of the live load, but the "boys" ignored both. Neglecting the weight makes a 10 percent mistake. Using nominal section of the plank, as many boys did, is wrong by 30 percent. The text did not invite such simplifications; in fact, its picture of the operation invited conservative design for the safety of the two workmen.

Those neglecting dead load recalled the rule for moving loads on a simple beam: moment under a load is greatest when midspan is midway between that load and the resultant of all loads. For two equal loads P spaced a ft apart on a span of L (Fig. 1), the abscissa of the first load is

$$b = \tfrac{1}{4}(2L-a) \;\ldots\ldots\ldots\ldots\ldots\ldots \;(1)$$

whence the left reaction and maximum moment are

$$R = P - aP/2L \;\ldots\ldots\ldots\ldots\ldots\; (2)$$

$$M_b = \frac{P}{8L}\,(2L-a)^2 \;\ldots\ldots\ldots\ldots\ldots\; (3)$$

Multiplying thru by $8L$, this becomes a quadratic in the unknown L, with exact and approximate solutions

$$L = \tfrac{1}{2}a + \frac{1}{P}\left[M + \sqrt{M(M+aP)}\right] \doteq a + 2M/P \;\ldots\ldots\ldots\ldots\ldots\; (4)$$

Now for the dressed plank, the section modulus is 13.2 in³, and $M=fS=13200$ lb-in = 1100 lb-ft. Substituting $M=1100$, $P=170+60=230$, and $a=2.5$, Eq. (4) gives $L=11.93 \doteq 12.06$. Also, it should be noted that those who used nominal dimensions found $S=18$, $L=15.44$. A short-cutter looked in tables, found $S=57.9$, computed $L=44.4$ ft, and never blinked at the ludicrous result; he had used stringer tables, suitable only if the workmen could walk the narrow edge of the plank!

Those who considered dead load and sought an exact analysis wasted time. One man let the plank weigh w lb per ft, found M in terms of a, b, L, P and w, set dM/db = 0, and derived

$$b = \tfrac{1}{2}L - \frac{aP}{wL+4P} \;\ldots\ldots\ldots\ldots\; (5)$$

$$M_b = \frac{(wL^2 + 4PL - 2aP)^2}{8\,(wL^2 + 4PL)} \;\ldots\ldots\; (6)$$

which led to a quartic in L. It can be solved by Horner's Method, but he backed up and solved (5) by gesngesagen. With $w=8.39$ lb per ft, $L=10.859$.

Much easier and close on the safe side is to assume dead moment under the load equal to maximum dead moment at midspan. Then (3) can become

$$M_b = \frac{P}{8L}\,(2L-a)^2 + \frac{1}{8}\,wL^2 \;\ldots\ldots\; (7)$$

which leads to a cubic or an easier gesngesagen to find $L=10.848$. Note how close this came; also that neglect of dead load gave a 10 percent longer plank and hence 14 percent overstress.

The text implied impact, so lack of definite data was no excuse to ignore it. Affecting only the value of P, it was simple to assume $I=30$ percent, $P=299$ and compute $L=9.12$ ft from (7). This is the best answer.

Hence the problem was a gem because the boys solved an academic problem and the men had an eye for good sound engineering, which wasn't difficult for those with enough experience to develop Eq. (7).

Our next is an optional problem that many skipped because it looked hard. Used by a state that locks old problems in the vault, it has been somewhat disguised.

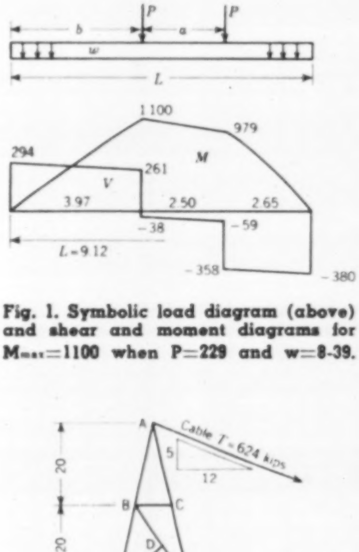

Fig. 1. Symbolic load diagram (above) and shear and moment diagrams for $M_{max}=1100$ when $P=229$ and $w=8\text{-}39$.

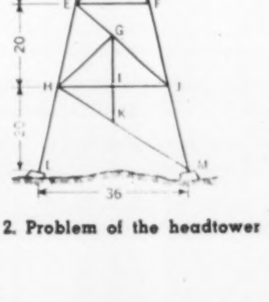

Fig. 2. Problem of the headtower bent.

EXAMGEM No. 17

A head tower bent (Fig. 2) is effectively pin-connected in its plane and guyed transversely. Compute stress in each member, and components of each reaction contributed by the cableway.

Fellowship Open in Public Water Supply

Graduate engineers and scientists wanting to enter the field of public water supply may be interested in the Harry E. Jordan Scholarship Award, established and sponsored by the Water and Sewage Works Manufacturers Association. The $1,500 award is intended for students who are unable to complete their professional training because of lack of funds. Primary consideration will be given to applicants who: (1) have received a college or university degree; (2) have maintained an undergraduate record of high scholarship; and (3) wish to engage in postgraduate studies leading to an advanced degree in science, engineering, or business administration.

Rules and regulations governing the awards are available from the American Water Works Association, 2 Park Avenue, New York 16, N.Y. Applications must be on file in the office of the AWWA by February 10.

Foreign Engineers Study Here Under IRF Program

Forty-eight highway engineering students from 38 countries have enrolled for postgraduate training under the 1960-1961 fellowship program of the International Road Federation. This is the largest delegation for a single school year since the IRF training program was inaugurated in 1949. Altogether, 264 engineers from 71 countries, including the current class, have participated in the program. Vietnam, with six students, has the largest representation in this year's group.

Forty-four of the 1960-1961 fellowship students are enrolled in United States universities (Ohio State, Yale, Northwestern and Purdue), and four are studying in Great Britain (Birmingham and Durham universities).

After completing their academic year, the engineers will make an observation tour of highway installations and industrial facilities. Then they will return to their home countries, where the specialized knowledge they have gained will be put to good use.

DECEASED

Alfred Edward Barnes (A.M. '28; M. '59), age 68, retired architect of Kansas City, Mo., died in that city recently. Mr. Barnes, who represented the third generation in a family of distinguished architects, was a member of the firm of Hoit, Price and Barnes from 1919 until it was dissolved in 1941. The firm designed many important structures in the Kansas City area. During the war Mr. Barnes was coordinating engineer for the architects at the Lake City Arsenal. From the end of the war until his retirement in 1958 he was with the Long Construction Company.

John Joseph Buckley, Jr., (J.M. '53; A.M. '59), age 29, superintendent of Buckley & Company, Inc., Philadelphia, Pa., was killed recently in the crash of a company plane he was piloting. Mr. Buckley was a 1953 graduate of the Drexel Institute of Technology.

John Joseph Burns (M. '55; F. '59), age 62, for the past five years building inspection engineer and civil engineer with the Philadelphia (Pa.) Bureau of License and Inspection, died recently in Wildwood Crest, N. J. Earlier Mr. Burns was assistant chief engineer of the Fairmount Park Commission, Philadelphia, and representative for Cox and Stevens, New York City naval architects, in charge of naval design on major shipyard contracts the firm had with the Navy.

Chester Wendell Cambell (M. '41; F. '59), age 58, since 1956 president and chief executive officer of the Foundation Company, of New York City, died in West New Brighton, Staten Island, on September 19. Mr. Cambell had been with the Foundation Company all but about 10 of his 35 years in heavy construction work. From 1938 to 1942 he was borough superintendent of the New York City Department of Housing and Building. At the time of his death he was serving a one-year term as president of the Moles, an association of leaders in the heavy construction industry in the New York area. Mr. Cambell had described some of his company's projects in CIVIL ENGINEERING.

George Edward Clark (A.M. '41; M. '59), age 65, for the past 26 years chief of the Construction and Repair Division of National Capital Parks, Washington, D. C., died there on September 19. Prior to 1932, Mr. Clark was an engineer and surveyor with the Rock Creek and Potomac Parkway Commission and engineer in charge of surveys, public office buildings, and parks.

Harold F. Clemmer (M. '26; F. '59), age 72, nationally known highway engineer who served for 29 years as engineer of materials for the District of Columbia Highway Department, Washington, D. C., died there on October 5. Mr. Clemmer joined the Highway Department in 1930, after previous service as an engineer of materials for the Illinois Highway Department and technical adviser to the Solvay Process Company in New York City. Since his retirement from the government last year, he had been a consultant to the District's Highway Department and to other groups.

Worth F. Cottingham (M. '58; F. '59), age 49, consulting engineer of Austin, Tex., died in that city on September 14. Mr. Cottingham had served as designer or consulting engineer on the construction of numerous public, industrial, and educational buildings in Texas, including the new State Headquarters Building for the Texas Department of Health. From 1945 to 1957 he was a partner in Wilson & Cottingham, and since the latter year had maintained his own practice.

Jasper Owen Draffin (M. '28; F. '59), age 75, professor emeritus of theoretical and applied mechanics at the University of Illinois, Urbana, died there recently. Professor Draffin, who was a Research Fellow at the University from 1914 to 1916, joined the engineering faculty there in 1919, was elevated to full professor in 1935, and remained there until his retirement a few years ago.

George E. Eldred (M. '47; F. '59), age 72, who retired in 1956 after 31 years with the U. S. Bureau of Public Roads, died recently in Detroit, Mich. He had been in the Bureau's branch offices at St. Paul, Minn., and Bismarck, N. Dak., for 20 years while the remaining 11 years were spent as division engineer at Madison, Wis. He was a World War I veteran, with overseas service in the 35th Engineers.

Clesson H. Field (A.M. '13; M. '59), age 76, retired associate professor of civil engineering at the University of Buffalo, died recently in Angola, N. Y. Mr. Field taught civil engineering at the University of Pennsylvania before going to the University of Buffalo. He retired in 1953, and of recent years had been associated with the consulting firm of Senior, Bissell & Bronkie, of Williamsville, N. Y. For 25 years Mr. Field was town engineer for Amherst, N. Y.

Morton Macartney (M. '14; F. '59), age 83, former chief of the Self-Liquidating Division of the Reconstruction Finance Corporation, Washington, D. C., died recently in Spokane, Wash. He joined the RFC staff in 1932, and had been engineer examiner, acting chief engineer, and chief of the Self-Liquidating Division. Earlier, he had served as assistant city engineer and city engineer of Spokane, and city engineer and director of public works at Orlando, Fla.

Earnest Boyd MacNaughton (M. '43; F. '59), age 79, who had a twofold career as engineer and banker, died recently in Portland, Ore. By 1925, when he was named vice president of the Ladd and Tilden Bank (sold that year to the U. S. National Bank), Mr. MacNaughton had served as a partner in the architectural and engineering firm of MacNaughton, Raymond and Lawrence, later MacNaughton and Raymond; and as a partner in Strong and MacNaughton, specialists in property planning, construction, and management. Since 1925, he had served as vice president, president and chairman of the board of the First National Bank, in Portland, Ore., and at the time of death was honorary chairman.

Harry H. Moseley (M. '45; F. '59), age 56, executive partner in the engineering firm of Havens & Emerson, Cleveland, Ohio, died in Lexington, Ky., on September 23. Mr. Moseley at the time of his death was in Lexington serving as referee between city officials and the Lexington Water Company in purchase negotiations for the utility. Connected with Havens & Emerson since 1928, Mr. Moseley had been a partner since 1950 and executive partner since 1958.

Edward L. North (M. '56; F. '59), age 59, for the past nine years president and chief engineer of the Northampton Con-

(Continued on page 104)

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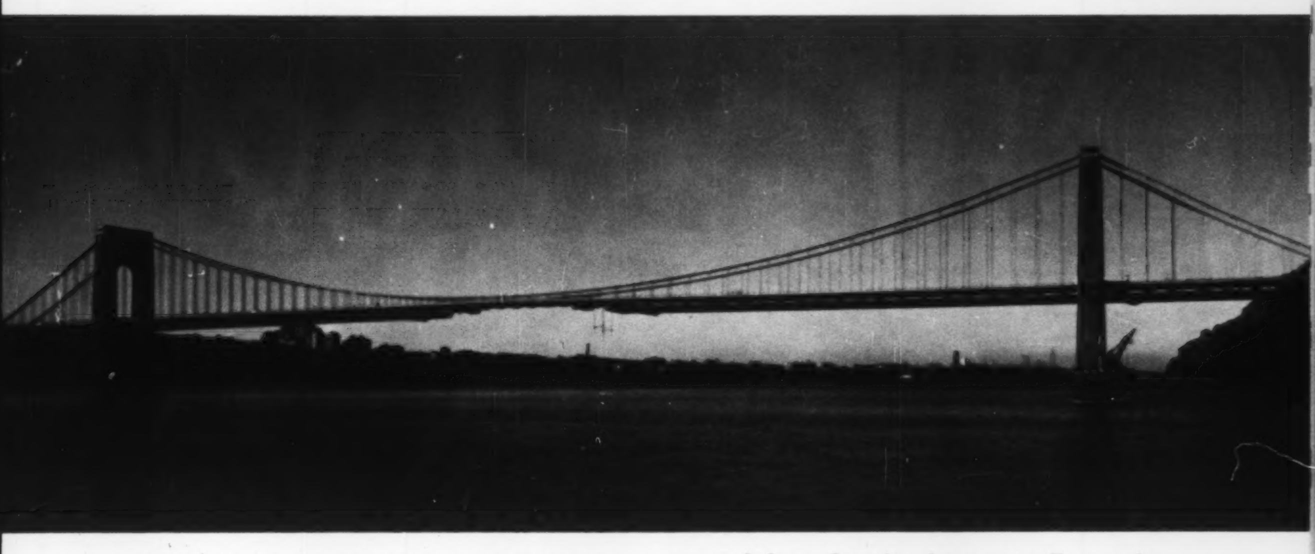


DOUBLE-DECK FOR GEORGE WASHINGTON BRIDGE. The 14,137-ton steelwork for the new lower-level roadway of the George Washington Bridge, fabricated and erected by Bethlehem, was completed in mid-1960. By building upward from flotation barges, traffic on the upper-level roadways was uninterrupted throughout the entire erection period. The Port of New York Authority, owner and operator, plans to open the lower deck to traffic in 1962.

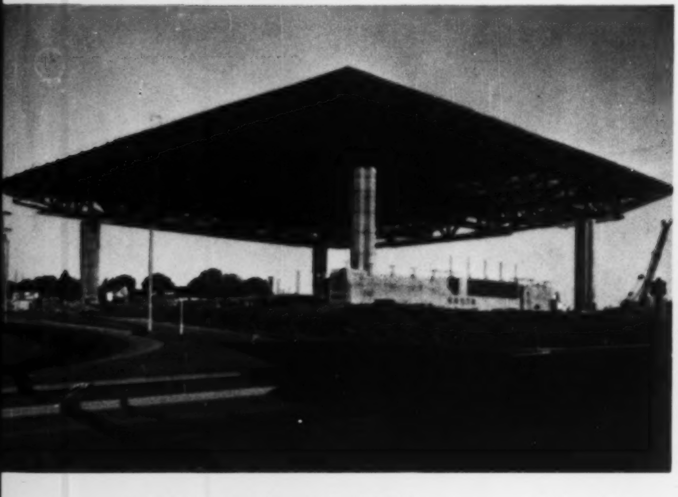
STEEL STRAND SUPPORTS CIRCULAR ROOF. This structure will help promote San Antonio, Texas, as a convention city. It's the Villita Assembly Building, owned by the Public Service Board of San Antonio. Its saucer-shaped roof is supported by 200 Bethlehem strand assemblies, consisting of prestretched strands with swaged fittings, and turnbuckles. Prestretching of the strand limited the residual constructional stretch, and also raised the modulus of elasticity.

General Contractor: G. W. Mitchell
Architects: O'Neil, Ford and Associates;
Nicanor Salas, project architect
Structural Engineer: W. E. Simpson Company
Steel Fabricator: Alamo Iron Works

BETHLEHEM STEEL

NEW BUILDING ON CAPITOL HILL. Bethlehem Wire Rope raises 15-ton steel truss, 36 ft long, one of 128 trusses required in erecting the steelwork for the House of Representatives Additional House Office Building in the nation's capital. Bethlehem is fabricating and erecting 23,000 tons of steel for this 9-story giant, which will be the largest of the buildings occupied by the legislative branch of government.

General Contractor: McCloskey and Company



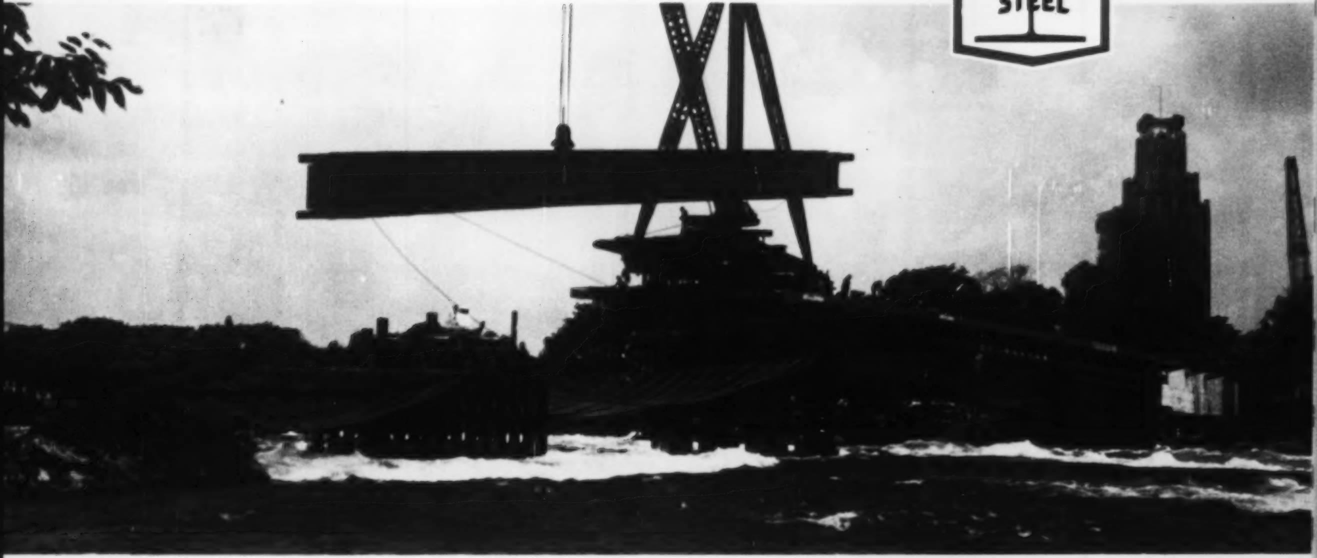
ROOF WITHOUT A BUILDING. The roof is in place, resting smartly on four 70-ft-high concrete columns. This method of construction permitted completion of the walls and interior work during winter months. It's the Memorial Coliseum, constructed by the Portland Exposition Recreation Commission for the City of Portland, Oregon. The roof structure, containing 1,250 tons of Bethlehem structural steel and some 35,000 Bethlehem high-strength bolts, was completed two weeks ahead of schedule.

Architects: Skidmore, Owings & Merrill
Structural Engineers: Moffatt, Nichol & Taylor
General Contractor: Hoffman Construction Co.
Structural Steel Fabricator: Poole, McGonigle, and Dick

STEEL PILING FOR SACRAMENTO RIVER CHANNEL. Bethlehem sheet piling awaits installation in walls of a barge canal and navigational lock being built near Sacramento, Calif., under supervision of U. S. Army Corps of Engineers. This is the first project in the West using sheet piling to construct a deep water channel.

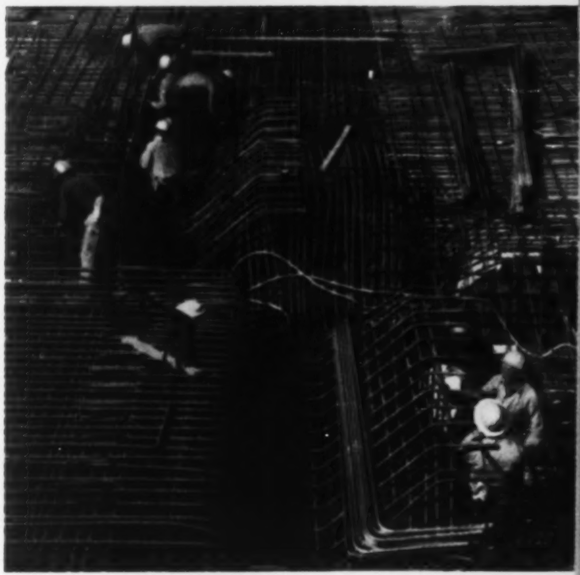
BETHLEHEM STEEL

BETHLEHEM STEEL



GOAT ISLAND BRIDGE ABOVE NIAGARA FALLS. Built across the roaring waters of the Niagara River is the American Rapids Bridge, part of the New York State Power Authority's park system along the American side of the river. The 450-ft main span is the longest of any bridge of its type in the country. This job required 2,200 tons of steel, fabricated and erected by Bethlehem.

Designers and Engineers: Praeger-Kavanagh



STEEL REINFORCES ATLAS LAUNCHING PAD. This complex of Bethlehem reinforcing bars is imbedded in a concrete launching pad at an Atlas missile base near Reardan, Washington. Unusually heavy concentration of steel bars is required to withstand terrific impact of an Atlas launching.

General Contractor: MacDonald-Patti-Scott-Leavell

NEW BY-PASS IN EASTERN PENNSYLVANIA. Pennsylvania Department of Highways recently began the construction of the Scranton By-pass. Here you see Bethlehem hollow drill steel boring blast holes for rock excavation. Other Bethlehem products being used are reinforcing steel, fasteners, wire rope, structural steel, and guard rail.

Contractor: Central Pennsylvania Quarry Stripping and Construction Co.

STEELWORK ERECTED IN LESS THAN A WEEK. This web-like steel skeleton is the framework for the Greek Orthodox Church, Oakland, Calif. Containing 115 tons of Bethlehem structural shapes, joined by Bethlehem high-strength bolts, it was erected in only $5\frac{1}{2}$ working days. In addition to speeding the work, bolting greatly reduced the noise in this residential area.

Architects and Engineers: Reid, Rockwell, Banwell & Tarics
General Contractors: Williams and Burrows, Inc.

This literature is yours for the asking

CATALOG 433. Dimensions, properties, and specifications for steel sheet piling used in cellular and straight-wall structures.

BETHLEHEM BEAM GUARD RAIL

BOOKLET 514. Technical data on an improved beam-type guard rail. Has helpful detail drawings.

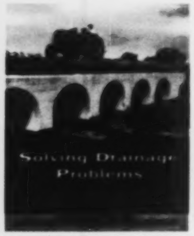
BETHLEHEM STRUCTURAL SHAPES

CATALOG S-58. Information and tables on structural shapes for architects, engineers, and designers.

High-Strength Bolting
for Structural Joints

BOOKLET 563. Uses of high-strength bolts in connecting structural steel members. Includes latest revisions of specifications.

BOOKLET 549. Picture story of the fabrication and erection of 53,000 tons of steelwork for The Chase Manhattan Bank.


Solving Drainage Problems

BOOKLET 425-B. The fabrication, design, and installation of steel pipe made from corrugated steel sheets.

BOOKLET 527-A. Contains joint details and procedures for welding reinforcing bars. Includes tables and drawings.

Bethlehem
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Steels

BOOKLET 345-A. Describes carbon and ultra-alloy steels used in rock drilling. Includes solid and hollow drill steel.

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New Publications

Materials testing . . . . Availability of the 1959 ASTM Proceedings is announced by the American Society for Testing Materials. The 1424-page volume records the technical accomplishments of the year, including 71 committee reports and 44 technical papers, together with their discussions. Another important feature is a subject and author index to all papers published by the ASTM in 1959. Copies, at $12 each, may be obtained from the ASTM, 1916 Race Street, Philadelphia 3, Pa.

Air Pollution . . . . An appraisal of factors involved in the increasing air pollution of the Charleston, S. C., area—made by the U.S. Public Health Service at the request of the South Carolina Department of Health—has been issued as Technical Report A60-6 of the Robert A. Taft Sanitary Engineering Center. The report also includes recommendations for the guidance of local officials in meeting the pollution problem. Copies may be obtained from the Librarian, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

Wave research . . . . "Laboratory Facilities in the United States for Research on Water Gravity Waves" is the title of a recent publication of Engineering Foundation's Council on Wave Research. The report—compiled by Prof. J. W. Johnson, F. ASCE, of the University of California—describes the facilities of each hydraulic laboratory. Free copies are available from the Council on Wave Research, University of California Engineering Field Station, Building 159, Richmond 4, Calif.

Standards . . . . A descriptive directory of more than 350 standardizing societies and groups in the United States has been issued by the National Bureau of Standards. Inquiries about the volume—entitled "Standardization Activities in the United States"—should be addressed to the National Bureau of Standards, Washington 25, D. C.

Highway research . . . . A wide range of research on roads and allied subjects is covered in publications of the Highway Research Board. Recent releases include Bulletin 242, "Bridges: Bearing Pads, Foundations, Scour and Waterways," $1.40; Bulletin 244, "Effects of Traffic Control Devices," $1.80; Bulletin 246, "Use of Steel-Tired Rollers and Two-Way Radio on Highway Construction," 80 cents; Bulletin 247, "Sign Supports," 80 cents; Bulletin 249, "Highway Needs and Programming Priorities," $1.80; Bulletin 250, "Pavement Performance Concepts," $1.40; Bulletin 251, "Asphaltic Concrete Construction," $1.00; and Bulletin 252, "Snow and Ice Control with Chemicals and Abrasives," 80 cents. Special Report 55, priced at $2.80, gives the research picture in the United States for 1959. Orders should be sent to the Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C.

Water primer . . . . Because everyone is affected in some measure by water problems, the U.S. Geological Survey has issued a popular non-technical "Primer on Water." The helpful 50-page manual is written in two parts: Part I covers the science of hydrology and shows the relationship of water to the earth; Part II is concerned with the magnitude and use of the total U.S. supply of water. Authors are Luna B. Leopold, F. ASCE, chief hydraulic engineer for the U.S. Geological Survey, and Walter B. Langbein, F. ASCE, research engineer. The primer costs 35 cents and is available from the U.S. Government Printing Office, Washington 25, D. C.

Education . . . . A useful reference for persons interested in the status of science and education in the U.S. has been published by the National Science Foundation. The reference—identified as "Statistical Handbook of Science Education" (NSF-60-13)—may be purchased from the U.S. Government Printing Office, Washington 25, D. C., for 55 cents.

Precast bridge members . . . . Saving of time and money in the design of precast concrete bridge members is the aim of a recent publication, entitled "Prestressed Bridge Beams." Design data are presented for 67 precast, prestressed highway bridge sections, including solid slab, cored slab and box girders, non-composite and with 3- and 4-in. composite slabs. All designs have been calculated with an IBM 650 electronic computer. Authors are Kenneth K. Kienow, A.M. ASCE, and John B. Scott, with Western Computing Consultants. Copies are available from Western Technical Publications, 5813 East 19th Street, Tucson, Ariz., at $6 per copy, $5 each for five to nine copies, and $4 each in lots of ten or more.

Screw thread standards . . . . Engineers needing to specify or use screw threads in countries outside the U.S. will find the "The Robertson Guide to World Screw Thread Standards" an invaluable aid. The illustrated guide lists over 2,000 standards covering the 33 countries which have national screw-thread standards. Copies may be ordered from the Small Parts Division of W. H. Robertson & Co., Ltd., Lynton Works, Bedford, England, at $1.50 each postpaid.

Urban renewal . . . . Issuance of a new pamphlet, entitled "The Urban Planning Assistance Program" is announced by the Housing and Home Finance Agency. Its purpose is to help states, regions, and cities "do the planning job necessary to arrest the spread of slum conditions." Copies, priced at 5 cents each, are available from the U.S. Government Printing Office, Washington 25, D. C.

Mass transportation . . . . In "A Study of Metropolitan Transit Agencies," Norman Kennedy and Wolfgang Homburger, M. ASCE, of the University of California Institute of Transportation and Traffic Engineering, examine the nature and functioning of public agencies that have been developed in major metropolitan areas of the U.S. and Canada to provide mass transit service. Chicago, Cleveland, Boston, New York, Toronto, San Francisco, and Los Angeles are among the cities studied. Inquiries should be addressed to the Institute of Transportation and Traffic Engineering, University of California, Berkeley, Calif.

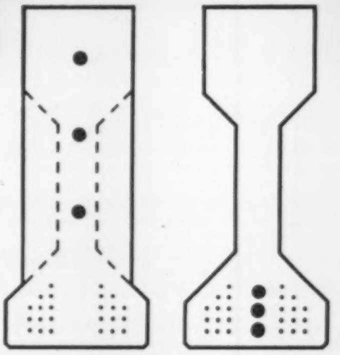
Water resources . . . . Water, called the nation's No. 1 water problem, is the subject of several informative government bulletins. "Federal Programs for Collection of Data on Water Use," prepared under the auspices of the Inter-agency Committee on Water Resources Subcommittee on Hydrology, is available from the U.S. Government Printing Office, Washington 25, D.C., for 25 cents. The Government Printing Office may also be queried about two bulletins of the Senate Select Committee on National Water Resources: Committee Print No. 8, entitled "Future Water Requirements of Principal Water-Using Industries," and Committee Print No. 30, "Present and Prospective Means for Improved Reuse of Water."

Concrete, bibliographies . . . . Researchers in the field of concrete will welcome two new bibliographies in the American Concrete Institute series. Bibliography No. 2, entitled "Evaluation of Strength Tests of Concrete," lists and annotates articles on compression tests of concrete, variations in test results, and evaluation of tests, issued from 1924 to 1958. Bibliography No. 3, on the "Fatigue of Concrete," lists 114 significant works published since 1898 on the fatigue of plain and reinforced concrete. The publications are $2.00 and $2.50, respectively, and may be ordered from the ACI, P.O. Box 4754, Redford Station, Detroit 19, Mich.

Bridge design . . . . "Manual of Bridge Design Practice"—published by the Bridge Department of the California Division of Highways—presents complete and practical procedures for designing the usual types of highway and railroad bridges. Each of its fourteen sections describes the application of the theory, interprets the AASHO or AREA design specifications, and provides a complete step-by-step example of the design. The manual is on sale postpaid at $12.50 a copy ($13 to residents of California and $13.50 outside the U.S.). Orders should be sent to the State of California Printing Division, Documents Section, North 7th Street and Richards Blvd., Sacramento 14, Calif.

Welding, aluminum pipe . . . . The American Welding Society has released a 40-page booklet of "Recommended Practices for Gas Shielded-Arc Welding of Aluminum and Aluminum Alloy Pipe." Prepared by the AWS Committee on Piping and Tubing, the publication covers, in condensed form, all phases of aluminum pipe welding techniques and heat treatment. Copies may be ordered from the American Welding Society, Dept. T, 33 West 39th Street, New York 18, N. Y., at $2 each.

Aerial view of bridge. Note railroad siding built expressly for handling bridge beams. As work progressed, river was diverted and siding laid over dry bed. Bridge designed by the Nebraska State Department of Roads. John Hossack, Acting State Engineer; G. C. Strobel, Assistant Acting State Engineer; Art Dederman, Bridge Engineer; General Contractor, Massman Construction Company, Kansas City, Missouri. Prestressed concrete members by Nebraska Prestressed Concrete Company, Lincoln, Nebraska.



End and center cross sections showing location of pre-tensioning strands and groups of post-tensioning strands in beams.

LOW BIDDER USES PRESTRESSED CONCRETE FOR MAJOR BRIDGE PROJECT

Massman Construction Company, the general contractor with the lowest bid, elected to furnish prestressed concrete girders rather than the structural steel alternate for the Platte River Bridge near Ashland, Nebraska.

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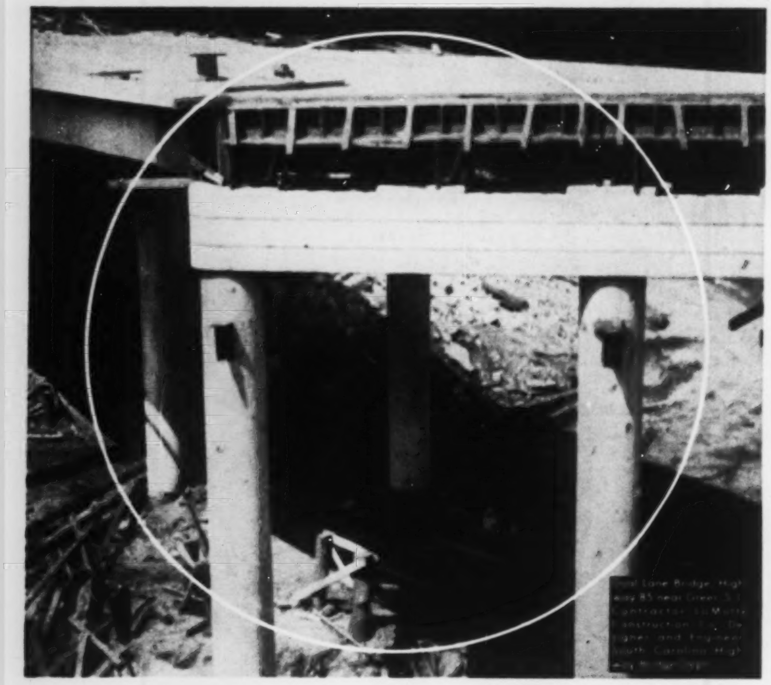

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Deceased

(Continued from page 96)

struction Company at Westhampton Beach, N. Y., died there recently. Mr. North had been in charge of the construction of sections of the Southern State and Captree parkways. Earlier he was vice president and chief engineer of the Eline Corporation and the Narline Corporation, on highway construction for the New York State Department of Public Works. He served overseas as an officer in World War II.

Herman Orr (M. '45; F. '59), age 59, Colonel, Construction Advisory Division, Corps of Engineers, Washington, D. C. died recently. From 1922 until 1940 Mr. Orr was with the Alabama Highway Department, which he served in capacities ranging from draftsman to assistant bridge engineer. He joined the Corps of Engineers in 1940. During the war years he served in the Western Pacific branch office of the Chief of Engineers, supervising the construction of airfields, army camps, and ordnance plants.

Olaf G. Otto (M. '21; F. '59), age 79, prominent Savannah (Ga.) contractor, died recently in that city. During his many years in the construction field Mr. Otto had been responsible for the erection of many industrial plants, commercial buildings and residences in the area. He recently completed construction of the Savannah football stadium. At the time of death he was in his third year as chairman of the board of directors of the Atlantic Savings and Trust Company. A native of Norway, Mr. Otto was naturalized in Savannah in 1914. Recently he was honored by the Savannah chapter of the D.A.R. "for his years of constructive service."

George Dewey Reed (A.M. '40; M. '59), age 60, for 22 years a sanitary engineer with the Kentucky State Board of Health, died in Louisville, Ky., on September 23. Mr. Reed's experience included several years with the Pitometer Company and an additional two years with the U. S. Public Health Service, which he left to join the State Board of Health.

A. H. Riney (M. '39; F. '59), age 72, vice president of the Phillips Petroleum Company, Bartlesville, Okla., died there recently. Mr. Riney had been connected with Phillips Petroleum since 1919—for many years as engineer on production and natural gasoline plant construction, and since 1938 as vice president in charge of the firm's engineering department.

Marvin C. Turner (M. '55; F. '59), age 54, since 1948 owner of Marvin Turner Engineers, with offices in Austin and Waco, Tex., died recently in Austin. Prior to establishing his own firm, Mr. Turner gained valuable experience in his specialty—the design and supervision of water distributions systems and water and sewage treatment plants—as design engineer and acting superintendent of the Austin Water Department.

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```
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R = 10 Ⓢ
F = 60 Ⓢ
L = ∘2 Ⓢ
FOR E = 100(50)300 BEGIN Ⓢ
FOR C = ∘00002(∘0000001)∘000021 BEGIN Ⓢ
I = E/SQRT(R ↑ 2 + (6∘2832 ∙ F ∙ L — (1/(6∘2832 ∙ F ∙ C))) ↑ 2) Ⓢ
PRINT (FL) = E Ⓢ
PRINT (FL) = C Ⓢ
PRINT (FL) = I Ⓢ
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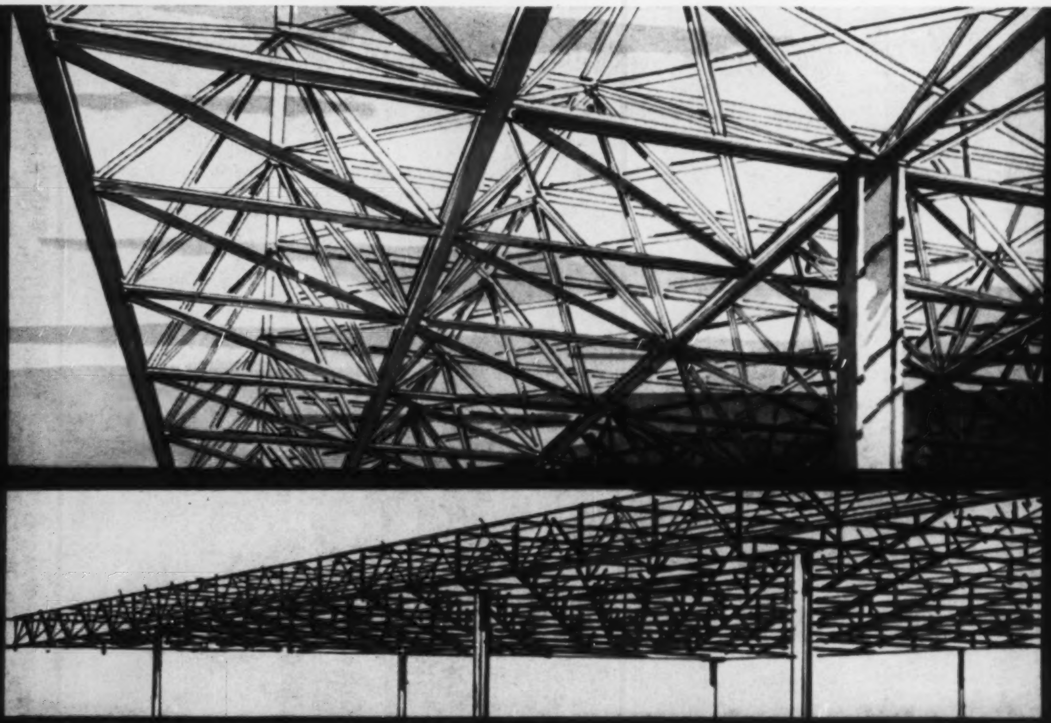

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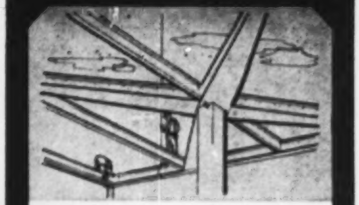

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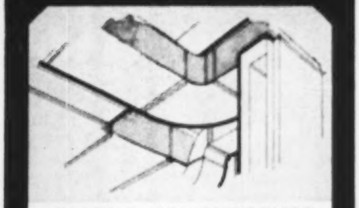

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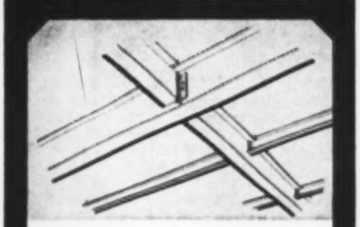

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News of Members

(Continued from page 28)

Joseph S. Fragomeni has been appointed superintendent of construction for the Youngstown Sheet & Tube Company's Chicago district. Prior to joining Youngstown he was project manager for Chas. W. Cole & Son, of South Bend, Ind.

Herbert J. Johnson, until recently resident engineer for Wilbur Smith and Associates, Kansas City, Mo., has been appointed manager of the Kansas City office of Burgwin and Martin. The office will be responsible for traffic, parking, and planning studies, services previously provided by the firm's offices in Denver, Colo., and Topeka, Kans. Mr. Johnson has directed a comprehensive origin-destination survey of the metropolitan area for the Kansas and Missouri State Highway Commissions.

W. L. Voorduin is president of the recently reorganized engineering department of the Development and Resources Corporation under its new name, the Regional Development Engineering Corporation. Under Mr. Voorduin, who will continue as vice president and director of engineering for the Development and Resources Corporation, the new firm will engage in work for other clients. Although the principal office will be at 57 Union Place, Summit, N. J., Mr. Voorduin will maintain a New York office at 50 Broadway.

John E. Kiker, Jr., has been named a representative of ASCE on Project A40 of the American Standards Association. This project is working on revisions of the National Plumbing Code. Dr Kiker is professor of civil engineering at the University of Florida.

James M. Lawson, who has been in charge of topographic map-making operations for the U. S. Geological Survey throughout Texas, New Mexico, Colorado, Wyoming, Montana and Alaska since 1956, recently retired from the Survey. Succeeding him as regional engineer at Denver is **Roland H. Moore,** assistant chief topographic engineer for research and technical standards at the Survey headquarters in Washington, D. C. Mr. Moore is chairman of the ASCE Surveying and Mapping Division's Committee on Research and Development.

John William Paxton has retired as a Colonel in the Corps of Engineers after more than 20 years of service, the last five as assistant chief of the Engineer Organization and Training Division in the Office of the Chief of Engineers, Washington, D. C., and as chief of the construction equipment branch of the Engineer School at Fort Belvoir, Va. Colonel Paxton is, at present, in private practice in Vienna, Va., as a construction consultant.

John E. Woodward, Jr., was assistant city planner for East Orange, N. J, this past summer. Mr. Woodward, a graduate of Virginia Military Institute, entered the Massachusetts Institute of Technology in September.

Henry B. Wildschut has been appointed Milwaukee County highway commissioner and director of public works. Mr. Wildschut, who has served six years as county expressway engineer, will take over his new post officially this month. He is president of the Wisconsin Section.

Earle J. Fennell, until recently assistant chief topographic engineer for program development with the U.S. Geological Survey, is now associate chief topographic engineer. In his new post he will be chiefly concerned with the day-to-day activities of the Survey's four area offices. Mr. Fennell is chairman of the executive committee of the Surveying and Mapping Division of ASCE.

Positions Announced

U. S. Navy Civil Engineer Corps. The Naval Civil Engineering Laboratory at Port Hueneme, Calif., has openings for Structural Engineers at the G.S.-11 ($7,560 per annum) and G.S.-12 ($8,810 per annum) level. A must is an engineering degree from an accredited university. In addition applicants for Structural Engineer G.S.-11 should possess at least three years of professional engineering experience, one year of which must have been in structural engineering; while those applying for Structural Engineer G.S.-12 should have four years of professional experience, one year of which must have been specialized in some aspect of protective construction and passive defense operations. There is also an opening in the Technical Division, Yards and Docks Supply Office, Port Hueneme, Calif., for a Supervisory General Engineer, GS-12, at $8,955 per annum. To qualify candidates must have a B.S. degree in engineering and four years of professional experience in at least two fields of engineering. Forward application Standard Form 57 to Code 12Cll, Placement Section, Industrial Relations Office, Construction Battalion Center, Port Hueneme, Calif.

City of San Diego. Applications are being accepted for the positions of Assistant Traffic Engineer, 21-64, at approximately $647-$713 per month; and Junior Civil Engineer, 21-52, at $532-$647 per month. General requirements for the openings include U. S. citizenship, the equivalent of graduation from an accredited four-year college with a major in civil engineering, plus a written examination and interview. In addition applicants for the job of Assistant Traffic Engineer should have at least two years of professional traffic engineering experience. Write to Clayton G. Swanson, Director of Personnel, Department of Civil Service and Personnel, Civic Center, Room 403, San Diego, Calif.

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Applications for Admission to ASCE, September 3-October 1, 1960

Applying for Member

Joaquin Aguerrebere Serrano, Mexico, D.F.
Cuneyt Mehmet Akova, Ankara, Turkey
Mell Aycock, Chicago, Ill.
Ghulam Hussain Balauch, Shidhi Village, Road Karachi 2, Pakistan
Federico Barona de la O, Mexico, D.F.
Hubert Beck, Frankfurt am Main, Germany
Carl Ray Borgwald, Tulsa, Okla.
Robert Nolan Bowen, Columbia, S.C.
Lloyd Garland Byrd, Ridgewood, N.J.
Donald Frederick Cairns, Granite City, Ill.
Robert Bennett Campbell, Ottawa, Canada
Edward Axel Cederborg, Oakland, Calif.
Shou-Shan Fan, Chicago, Ill.
Mohammed Rashid Faruqui, Karachi, Pakistan
Dennis E. Feigenspan, San Antonio, Tex.
George Eckerson Fischer, New York, N.Y.
William Don Freeburn, South Holland, Ill.
Robert John Giesen, Washington, D.C.
Mal Goebel, Middleport, N.Y.
Alfredo Heres Gonzalez, Santurce, Puerto Rico
Richard Silver Hart, San Diego, Calif.
Robert Cary Heterick, Washington, D.C.
Yi Huang, New York, N.Y.
Harold Mitchell Ibach, Jr., Minneapolis, Minn.
Masami Iwamura, Honolulu, Hawaii
William Percy Johnson, Jr., Erie, Pa.
Nicholas Kockinakis, New York, N.Y.
Marion Jackson Kopetz, Kansas City, Mo.
Jack Paul Kourkene, San Francisco, Calif.
Leonard Charles Lambert, London, England
Chester Laurice Lucas, Bridgeport, Conn.
Shiv Darshan lal Luthra, New Delhi, India
Alfonso Francis Meketarian, Cleveland, Ohio
Edmund Severn Miller, Columbus, Ohio
Harold Thomas Miller, Long Beach, Calif.
John Guffey Miller, Washington, D.C.
Kutti Narasimha Chary, Rajasthan, India
Martin Rendle Nelson, Boston, Mass.
Hubert William Nieman, Chicago, Ill.
Richard Allen Overmyer, Philadelphia, Pa.
Orhan Ozalp, Denver, Colo.
Allan Claire Pitzen, Victoria, Australia
Ronald Bruce Reeves, Champaign, Ill.
Ik Hwan Row, Cholla Nomdo, Korea
Nikhilesh Roy, Pasadena, Calif.
Raoul Sabljak, Vancouver, British Columbia, Canada
Harold Henry Schlintz, Fresno, Calif.
Morris Joseph Siegel, Philadelphia, Pa.
Joseph A. Smedile, Chicago, Ill.
Richard James Smith, Los Angeles, Calif.
Karel Frank Smrha, Seattle, Wash.
Walter Milton Street, Detroit, Mich.
Lavern Haven Swords, Peoria, Ill.
Kurt Siegfried Tannenwald, Chicago, Ill.
Mehmet Nejat Tokay, Chicago, Ill.
Salvatore Joseph Trapani, Springfield, Ill.
Martiniano Urrego, Medellin, Colombia
Chen-Hsiu Wang, Seattle, Wash.
David George Wheeler, Chicago, Ill.
Richard Henry Wolters, Rock Island, Ill.
Lenard Berton Young, Fort Worth, Tex.
Dimitar Zatakov, San Francisco, Calif.

Applying for Associate Member

Charles Albert Babendreier, Washington, D.C.
Theodore Bronowski, Gary, Ind.
Edgar French Campini, Sacramento, Calif.
Hubert D. Chin, Bethlehem, Pa.
William Franklin Coates, Jr., Franklin Park, N.J.
Alvin Webb Dunbar, Aguirre, Puerto Rico
Ibraham Ali Ebeido, New York, N.Y.
Robert John Elliott, New Whiteland, Ind.
Joe Andrew Farmer, Jr., Anderson, S.C.
Gene Lloyd Faulkner, Memphis, Tenn.
Hugo Vicente Fonseca Viso, Caracas, Venezuela
William Don Freeburn, Chicago, Ill.
Ronald Keeney Grady, Baton Rouge, La.
Herbert Wray Gregory, Portland, Ore.
Hasan Ahmad Hejazi, Columbus, Ohio
Sam Penland Hensley, Marietta, Ga.
Henrique Hirschfeld, Sao Paulo, Brazil
Arthur Eugene Howard, Anchorage, Alaska
Yuki Jofuku, Los Angeles, Calif.
Prakash Vishnu Limaye, New York, N.Y.
Pai-Chuan Lin, Washington, D.C.
Prasit Mahattanakul, Pittsburgh, Pa.
Francis Kai Tye Mak, Singapore, Malaya
Parounag Abraham Maljian, Pasadena, Calif.
Hagop A. Manuelian, Beirut, Lebanon
Theodore Winton Merrill, Washington, D.C.
Arthur James Muller, Natal, South Africa
Billy Buford Neely, Knoxville, Tenn.
Frederick George Pohland, West Lafayette, Ind.
Antonio Ramos, Rizel, Philippines
Shantilal Chimanlal Rangwala, Ahmedabad, India
Tipirneni Shivaji Rao, Houston, Tex.
Thomas To Shen, Chicago, Ill.
Bradford Hall Spring, Potsdam, N.Y.
Robert Hugh Tawes, San Francisco, Calif.
Vythilingam Tharmalingam, Sydney, Australia
Bansi Lal Vaishnavi, Ithaca, N.Y.
Rameshwar Dayal Verma, Jodhpur, India
Peter Watermeyer, Cambridge, Mass.
Muhammad Yunus Kureshy, Karachi, Pakistan

[*Applications for the grade of Associate Membership from ASCE Student Chapter Members are not listed.*]

Non-ASCE Meetings

American Institute of Chemical Engineers. Annual meeting at the Statler Hotel, Washington, D. C., December 4-7.

American Society of Mechanical Engineers. Annual winter meeting at the Statler-Hilton Hotel, New York, N. Y., November 27-December 2. In conjunction with the annual meeting ASME will sponsor the twenty-fourth National Exposition of Power and Mechanical Engineering at the New York Coliseum, November 28-December 2. In addition a colloquium on shock and structural response will be held on November 30, at 9:30 a.m.

Building Research Institute. Annual fall conference on the use of preassembled large building components at the Shoreham Hotel, Washington, D. C., November 15-17.

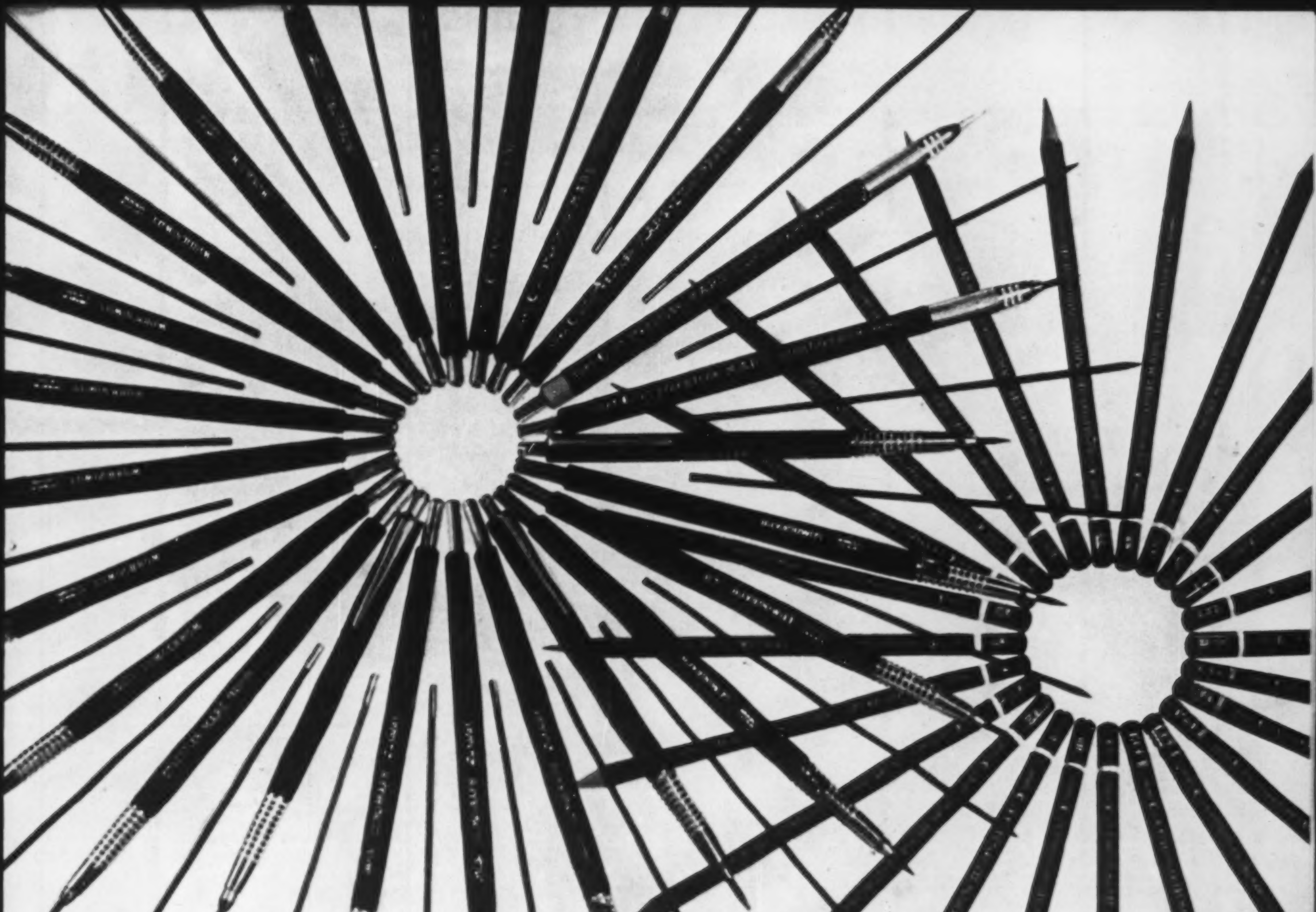
FIP-RILEM. Symposium on injection grout for prestressed concrete at Norges Tekniske Hogskole, Trondheim, Norway, January 5-7, 1961. For further information contact Professor I. Lyse, NTH, Trondheim, Norway.

Public Health Service. National Conference on Water Pollution, Washington, D. C., December 12-14. The information unit for the conference is located in Room 4310, HEW Building, South, Department of Health, Education and Welfare, Washington 25, D.C.

University of California. Two western conferences on prestressed concrete buildings presented by the University at the Biltmore Hotel, Los Angeles, November 14-15, and at the Sheraton Palace Hotel, San Francisco, November 21-22.

University of Illinois. Third Sanitary Engineering Conference on disinfection and chemical oxidation in water and waste treatment, sponsored jointly by the Department of Civil Engineering and the Division of Sanitary Engineering of the Illinois Department of Public Health on the University's campus at Urbana, January 31 and February 1, 1961. Ben B. Ewing, Associate Professor of Sanitary Engineering, University of Illinois, Urbana, or C. W. Klassen, Chief Sanitary Engineer, Department of Public Health, Springfield, Ill.

University of Texas. Sixth Industrial Hygiene and Air Pollution Conference on new environmental problems in the construction industry, December 3. Co-sponsored by the University's College of Engineering, the Texas State Department of Health and the Gulf Coast and North Texas Sections of the American Industrial Hygiene Association at the Austin campus. E. F. Gloyna, Professor of Civil Engineering, Engineering Laboratories Building, Room 305, the University of Texas, Austin, Tex.



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drafting and printmaking NEWS

Problem: How to Microfilm Old Drawings So They Can Be Read

Microfilming is widely used for recording and storing the mountains of drawings and data individual companies must maintain. But to anyone who works with microfilmed drawings, they know the condition of the original is very critical in order to obtain a readable microfilm print. Faint lines, weak lettering and dimension markings, creases, and dirt smudges become impossible handicaps when the originals are first reduced 16 to 29 times and then enlarged for reading or reproduction. Today's advanced drafting techniques avoid this problem in new drawings, but what about a company's old drawings? Few are ever suitable for microfilming without extensive, meticulous restorative work. Yet, something must be done with these old drawings if the microfilm file is to be complete and useful.

Dietzgen answers this problem with a number of products and techniques developed for restoring old drawings preparatory to microfilming. The Dietzgen "wash-off" process is preferred by many because no darkroom work is involved. Corrections are easily made on the "wash-off" media eliminating the tedious retouching of a photographic negative. Backgrounds come clean with a wipe of a brush or sponge so that even the finest line stands out sharp and clear.

Dietzgen's "wash-off" process puts new life into old drawings quickly and inexpensively.

Today thousands of old drawings which appeared hopeless subjects for microfilming have been salvaged by Dietzgen products and techniques . . . and it's this experience which can prove invaluable to you if old drawings have handcuffed your company's microfilm program.

JETS, MISSILES AND DIAZOS

A large manufacturer of components for jet aircraft and guided missiles complained: "We're having trouble getting all the prints we need each day with our present printmaking facilities. We must step up our printing speed. However, we want to standardize on blueline diazo prints and would like to run our printers at very nearly a constant speed. Also, we have to work with a wide range of reproducibles, which really complicates the problem."

Four companies coating diazo papers were given the problem. Two immediately said it was impossible. The third submitted a specially coated stock which provided the speed but not the print quality required.

Dietzgen had answered similar problems before. With a slight formula change in one of the regularly catalogued Dietzgen diazo papers, the extra speed was added to all the other needed characteristics already in formulation. This custom-engineered product was tested and immediately adopted. It has since been used continuously for the company's large volume needs and is pronounced "perfect." Print production soared.

Dietzgen's long and broad experience with Diazo coatings and equally long and broad research program frequently combine to provide both counsel and advanced products not obtainable elsewhere.

Drafting-Printmaking Booklet reports new techniques for solving engineering and production problems

This new 36 page booklet describes a wide variety of engineering and production problems that have been solved with advanced techniques in drafting and printmaking pioneered by Dietzgen. The concise, problem-solution approach suggests ways in which you may improve the efficiency within your engineering department or eliminate production bottlenecks. Write today on your company letterhead for the Mechanics of Modern Miracles. Ask for Publication SPD2-L 81. Eugene Dietzgen Co., Chicago 14, Illinois.

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These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which cooperates with the national societies of Civil, Electrical, Mechanical, Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or non-members, and is operated on a non-profit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 60 percent of the first month's salary if a non-member, or 50 percent if a member. Also, that you will agree to sign our placement fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include 8 cents in stamps for forwarding application to the employer and for returning when possible.

The New York office will be open on Thursday evenings until 7:00 o'clock for interviews.

Men Available

Civil Engineer, M. ASCE, B.S.C.E., 33. Ten years' solid experience in heavy construction and six and a half years' on large overseas projects. Able administrator accustomed to large responsibilities. Salary, $13,000 minimum, a year. Location, Europe, Far East. C-607.

Civil Engineer, F. ASCE, P.E., N.Y.C., B.S.C.E., 27. Five years' experience, designing, estimating, and drafting, bridges, cofferdams, caissons, tunnels, power plants, dams, cableways, docks, pressure vessels, structures for petroleum refineries, industrial buildings, highways, grading and drainage. Location, New York. C-608.

Construction Superintendent, A.M. ASCE, B.S.C.E. Eleven years' field experience, including five years' as superintendent, on steam plants, hospitals, commercial and industrial buildings. Salary, $9,360 a year. Location, East or Middle West. C-609.

Project Manager, Engineer Executive, F. ASCE, B.S.C.E., B. PH., 51. Feasibility reports, civil engineering surveys, highway location and design, heavy construction management and supervision. Available immediately. C-610.

State or Deputy State Sanitary Engineer or Director of Division, F. ASCE, M.S.S.E., Ph. Engr. Major experience includes supervision of water and sewage works for foreign consultant and experience in four state health departments as principal assistant engineer of one and chief engineer of another. Salary, $10,000 a year. C-611.

Executive Engineer, F. ASCE, P.E., N.Y., CDR, CEC, USNR, B.C.E., 50. Extensive construction, design, planning management experience on large scale Navy & civilian construction programs. Total 30 years' experience on all type projects. Excellent references available. C-612.

Chief Engineer, F. ASCE, registered N. Y. and N. J., graduate C.E., 38. Seventeen years' construction, defense, industrial, utility, public works experience; and 12 years' as instructor and department chairman, evening session. Desires executive position. C-613.

Management and Engineering Executive, M. ASCE, registered P.E. in N. Y., B.S. and Master's in Civil Engineering. Wide construction engineering experience in chemical and industrial facilities includes all phases of administration and management. Complete charge of planning, scheduling, cost control, contracts, quality control, safety and purchasing. Location, Buffalo, N. Y. area. C-614.

Owner's Representative, Architect Engineer or Contractor's Coordinator, F. ASCE, registered N. J. Retired civil engineer, thoroughly experienced in heavy construction, concrete, roads, railroads and airports, mass housing and extensive maintenance experience. Formerly chief operations division, Corps of Engineers, Deputy Chief Facilities Branch on Missile Construction, Ordnance Department, U.S.A. GS-15 assignment upon retirement. Presently employed on school construction, available two weeks notice. Salary commensurate with responsibility. C-615.

Sanitary Engineer, M. ASCE, B.C.E., 28. Five years' experience with sanitary consultants including responsible work in design, report and specification writing, cost analysis, and field supervision. Also involved in purchasing, expediting, and testing equipment and materials. Salary $7,500-$8,500 a year. Location, New York City or Northern New Jersey. C-616.

Development Engineer, F. ASCE, B.S.C.E. Twenty-five years' in the development of site for apartment and housing projects; design and construction of recreation facilities; protection of shore front rivers and ocean; promotion of new business. Salary, $12,000 a year. C-617.

Office Engineer, A.M. ASCE, B.S.C.E., 34. Three years' experience in the petroleum industry, six months' as maintenance engineer. C-1186-Chicago.

Office or Field Engineer, A.M. ASCE, B.S.C.E., 32. Chief of party on agricultural drainage survey and construction; and field engineer in charge of quantities records, cost accounting, permanent materials, camp water and sewerage systems on foreign irrigation projects. Speaks Spanish. Salary, $9,600 a year. Location, Foreign. C-1187-Chicago.

Construction Engineer, M. ASCE, P.E. License, Texas, B.S.C.E., 43. Ten years' experience in general oil field construction. Background in design, specifications, inspection and supervision of construction and office routine. Salary, $9,500 a year. C-1188-Chicago.

Senior Construction Administrator, M. ASCE, registered civil engineer and surveyor in several states, Purdue and Rose Polytechnic, 51. Engineer in charge of projects on highways, airports and railroads for 18 years and for six years superintendent for industrial and institutional building contractors. Salary, $11,000 minimum, a year. Location, central United States. C-1189-Chicago.

General Manager-Construction, A.M. ASCE, registered in Texas and Illinois, B.S.C.E., 32. Nine years' construction management experience on multimillion dollar projects such as oil refineries, chemical plants, missile launch facilities, large airplane hangars, etc. Thoroughly experienced in general and mechanical contracting operation. Salary, $13,500 a year. Location, Texas or Southwest. C-1190-Chicago.

Office or Field Engineer, A.M. ASCE, B.S.C.E., 25. Three years' experience in highway and airfield design, construction and inspection, material testing, and location surveying. Salary, $6,400 a year. Location, West or Midwest. C-1191-Chicago.

Project Engineer, A.M. ASCE, Registered in California, CE, 31. Five years' experience with consulting engineer on the design of bridges, buildings, docks, and highways; one year as resident engineer on bridge project; two years as airport engineer officer, Corps of Engineers; and one year with State Highway Department. Salary, $10,000 a year. California. SE-1891.

City or General Manager, M. ASCE, 50. Engineer of twenty-seven years' experience in management, design and construction desires position as city manager, city engineer or general manager of engineering or construction firm. Is retired military engineer. Directed construction of many large military installations, world-wide. Location, West Coast and Southwest U.S. Salary, $10,000 minimum, a year. SE-1863.

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Field Engineer, A.M. ASCE, CE, 31. Prior to college and during summer vacations while in college gained experience in construction industry as union journeyman carpenter. For past fifteen months civil engineer with federal agency in charge of plans, surveys, and construction engineering on supervisory level. Salary, $6500 a year. Location, West, Northwest. SE-1806.

Designer, A.M. ASCE, EIT certificate, CE, 28. Three years' experience mostly in highway design including design and layout of interchanges and intersection design studies. Salary, $7,200 minimum, a year. Location, San Francisco Bay Area. Se-1663.

Plant Engineer, A.M. ASCE, CE, 35. Eleven years' experience, plant engineering, structural design, construction management including machinery erection, maintenance, specifications, reports, cost estimates, planning, supervise and administer for pulp and paper company, industrial consulting engineers, and architects. Salary, $11,400 a year. Location, West Coast, South. SE-1786.

Positions Available

This is only a sampling of the jobs available through the ESPS. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

Soils Engineer, with post graduate training and experience in soils engineering, for a firm of consultants in soil mechanics and foundation engineering. Knowledge of French or Spanish desirable. Locations, Canada and abroad. F 9687.

Associate Editor, B.S. in civil engineering, or other engineering field, or science-journalism, recent graduate considered, with some experience and liking for technical editing and writing. Will be responsible for bulk of editorial processing of paper and material for a monthly journal, writing and/or rewriting technical papers and features, reviewing engineering publication, etc. Salary, $6,600 a year. Location, Midwest W-9682.

Engineers, Structural Designers, graduate civils, for work on bridges and structural projects. Several years' experience desirable but not mandatory. Overtime allowance, hospitalization, insurance and retirement program. Submit experience record, references, locality preferred and salary requirements. Locations, Chicago, Ill.; Cincinnati, Ohio; Lansing, Mich.; and Louisville, Ky. W-9671.

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Permanent new position for graduate civil engineer in the salary range of $511 to $588 a month (plus longevity pay). Vacation, sick leave, dual pension program, and other fringe benefits. Must be U.S. citizen and possess an EIT certificate. Some related experience desired to work in design and construction of sewer, water, street, sidewalks, and curbs. Travel expenses paid on invitation and moving expenses paid for selected candidate.

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Sales Engineer, degree preferably in civil engineering, business or scientific fields, with sales experience in concrete, construction or heavy industrial sales. Will make sales and service calls on architects, engineers, contractors, etc., representing technical building materials allied to the concrete industry. Three to six months informal organized training. Salary, plus car, fringe benefits. Location, Midwest. W-9663.

Civil Engineer, graduate, to supervise construction of a large reinforced concrete parking garage for one year with the possibility of continued employment due to extensive redevelopment program. Submit complete resumé and state salary desired; also when available for interview. Location, New England. W-9621.

Director of Engineering, M.S. in civil engineering, to take charge of the design, maintenance and improvement of large bulk handling equipment such as would be found at terminal facilities. Experience with grains or cereals desirable. Should be experienced in negotiating with and directing work of engineering consultants or construction firms. Advancement within a reasonable time. Salary good. Location, New York City. W-9618.

Designer, degree or equivalent, U.S. citizen, single to 45, with good recent experience in designing, detailing, layout and drafting dock and harbor structures. Will work with structural engineer and port and harbor engineer in developing consulting design engineering type plans in field for consulting design engineer. About two years. Salary, $1,000 a month plus per diem. Location, Southwest Pacific in Far East. Sj-5612-R.

Estimator, Grad CE or Archt, U.S. citizen, under 55, and with six years' experience or equivalent. Estimating building costs, some familiarity with specification writing for buildings (not engineering structures) for government. Permanent. Salary $8,484-$10,308 a year Location San Francisco Bay Area. Sj-5610-R.

Estimator, engineering background, 30-50, to do quantities work and pricing as part of staff of general contractor. Light to heavy commercial and industrial buildings. Salary commensurate. Location, San Francisco. Sj-5620.

Supervisor, single. Must know triaxial sheer tests; also something about plastic and water content, water limits, density consolidation, compaction tests, moisture adsorbation and classification and concrete dam installations. Should be capable of administering complete program from start to finish manned by native field personnel and lab assistants. Temporary four to five months. Salary, $10,800 a year plus housing. Location, Africa. Sj-5583.

Teachers, CE, MS, U.S. citizen, with some teaching experience. To teach mechanics of materials, material lab, structures and soil mechanics. Salary, $3,000 for 6 mos.; $6,000 for 9 months. Location, Central California. Sj-5577.

Field Superintendent, construction background (will consider carpenter who has worked up to superintendent), to age 40. With good experience in the field of light construction, commercial buildings, small structures. To work in Northern California for a construction company with headquarters in San Francisco. Salary, $6,600-$7,800 a year. Sj-5573

Field Engineer, CE, prefer grad with some experience; able to do field and office operations and occasionally some lab work on foundations, investigations, observe and supervise test drillings, control of compactions and grading, observe and report foundations and pile driving for small and growing consultant. Salary, about $7,200 a year. Location, Marin County. Sj-5565.

General Manager. Top man to run job. Must know construction of large shopping centers, with numerous commercial, office and motel buildings for general contractor. Salary, $1,000-$1,500 a year depending on experience. Location, San Francisco Peninsula. Sj-5557.

Sanitary Executive, technical grad (possibly ChE or ME), to 55. Well qualified by recent and extensive experience in technical management and administration; particularly interested in pollution experience related to functioning of public control boards. Must have past record of staff management and administration of technical matters; including public contact, addressing public and private individuals, groups and audiences; high level committee meetings (technical and non-technical); able to collect, evaluate, report and interpret a complete body of information relating to air pollution from motor vehicles for public agency. Submit letter of application with detailed statement of qualifications, age, availability, personnel. Salary, $17,000 a year. Location, California. Sj-5555.

Resident, grad, to 55. Senior status and recent experience at substantial level in providing liaison, acceptance and inspection between design engineering and construction. Will engage in development of whole property from prestressed concrete dock for materials removal and handling and provide for ultimate shipment for engineering contractor. Spanish desirable. Salary, $11,000 a year plus 1½ months annual bonus, living allowance; without young children. Two-year contract. Location, South America. Sj-5553.

Construction Cost Engineer, B.S.C.E., 25 to 35. Two to four years' experience with a general contractor in preparation of cost estimates for perfection of work and cost estimates to be presented for periodic pay estimates for general contractor and sub-contractor. Salary, $8,400 a year. Location, Alabama. C-8313.

Engineers. (*a*) Senior regional engineer, graduate civil or structural. To be responsible for Chicago office operations including Northern Illinois and Indiana, doing promotional field work in uses of structural steel. Should be able to discuss design problems encountered in structural steel, be interested in promotional work and present subject as well. Salary open. (*b*) Regional engineers, requirements as above, territories, Kentucky, Nebraska, Headquarters, Omaha, including western Iowa, Nebraska, Wyoming, Colorado and western Kansas, Minneapolis, including Minnesota, North and South Dakota, eastern Montana and western Wisconsin for a trade association. Should be registered structural engineer or able to obtain license. Salary open. Employer will negotiate placement fee. C-8282.

Public Relations Director. Opportunity to combine engineering, promotional and editorial background and interests. To be in charge of all creative services for growing Chicago-based industrial and civil engineering firm. Salary, $10,000-$12,000 a year. Employer will negotiate placement fee. Location, Chicago Loop. C-8256.

Structural Designer, graduate, with three or more years' experience in structural steel and reinforced concrete design on commercial, industrial apartment and institutional building for a consultant. Prefer man with P.E. license. Salary, $7,500-$10,000 a year. Employer will negotiate placement fee. Location, Chicago. C-7852.

ENGINEERS
STRUCTURAL DESIGNERS

Openings in our Chicago, Cincinnati, Lansing and Louisville offices for graduate engineers for work on bridges and structural projects. Several years' experience desirable but not mandatory.

Overtime allowance, hospitalization, insurance and retirement program for continuing employees.

Submit experience record, references, locality preferred and salary requirements in first letter.

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LOUISVILLE, KENTUCKY

ONLY LOADER WITH 5-WAY

Allis-Chalmers tractor loaders offer extended service life, far less downtime by thoroughly cleaning all air and filtering all hydraulic oil.

Unmatched filtering protection—that's what you get in all Allis-Chalmers tractor loader models.

Air is double filtered by:

1. air breather
2. air filter

Hydraulic oil is cleaned by:

3. full-flow micronic filter
4. conical screen
5. magnetic filter

This 5-way filtering protection brings peak hydraulic operating efficiency . . . extended service life.

move ahead with

1
2
3
4
5
ALLIS-CHALMERS
TL 16

HYDRAULIC PROTECTION

Complete filtering protection is just another way Allis-Chalmers tractor loaders set the pace in the loader field. They also feature: *pin-connected axles* that eliminate shifting and rolling under load; *exclusive single-lever control* of all speed and direction; *safe, well-located dump cylinders* that are up and away from dirt; *extra reach* for easier dumping and *added stability* for moving big loads without tipping or spilling.

Your Allis-Chalmers dealer can give you facts on all 5 tractor loader models—ranging in capacity from 1 to 5 cu yd, in power from 76.5 to 130 horsepower. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

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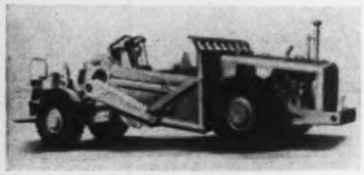
... power for a growing world

EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Twin-Power Scraper

After extensive testing, both on proving grounds and actual contractor operations, this company has announced full production of a new twin-power scraper of 14 cu yd struck capacity and 20 yd heaped S.A.E. rating a 1:1 slope. Designated as the Model TS-14, this all-wheel drive scraper is powered by two GM 4-71 engines, each with a separate Allison Torqmatic Drive consisting of torque converter and 4-speed semi-automatic transmission. Converter lock-up in each Torqmatic Drive gives maximum fuel economy with efficient use of the 296 total engine hp on grades and long high speed hauls. Air assist remote control and full power shift enables the operator to change from one speed range to another by a simple flick of the wrist. Tires are 24.00 x 25. Two hydraulic jacks provide full 90-deg steering.



Twin-Powered

All scraper operations, bowl, apron and ejector, are hydraulically and independently controlled. Ability to self-load and to work under the most adverse conditions is a feature of this scraper. All-wheel drive gives it a wide range of usefulness for small yardage jobs such as secondary road construction, soil conservation, stripping and industrial grading as well as for medium and big, high speed, high production earthmoving projects. **Euclid Division, General Motors Corp., CE-11, Cleveland 17, Ohio.**

Traffic Lane Marker Dots

Thousands of white dots marking lanes on the new 3.25-mi section of the San Jose-Los Gatos Freeway also mark what many traffic and highway engineers term one of the most important safety advances in recent highway design.

Clearly visible at all hours, rain or shine, the 4-in., three-dimensional lane delineator buttons represent the culmination of some 6 years of intensive and exacting research and development work conducted under the guidance of the Materials and Research Laboratory, California Division of Highways, Sacramento.

The secret of their clear visibility day and night is the unusually high reflectance built into the buttons. Each button contains several hundred tiny and optically clear glass spheres, the largest not more than two one-hundredths (.02) of an inch in diameter.

Imbedded in a special, tough, resilient, virtually unbreakable and wear-proof white polyester resin, the glass spheres reflect light brilliantly from any source, hence the high reflectance which makes the buttons clearly visible. Because of their shape, the buttons also cause an audible and plainly felt vibration in any car whose tires run along or across them. **Grant Wiswell & Co., CE-11, 2566 Bay Road, Redwood City, Calif.**

Silent Demolisher

The ear-splitting, nerve-jangling noise of jackhammers and the banging thud of "headache balls" breaking concrete walls and foundations is a familiar trade-mark of demolition work. But now this problem has been overcome by a speedy, silent tool known as the Oxweld ACL-4 Powder Lance. Powder-lancing is a process that actually burns through concrete and other materials without the slightest noise or vibration. Lengths of ordinary black iron pipe are fitted into the end of the Oxweld ACL-4 Powder Lance which is connected to an oxygen supply and a source of special Oxweld metallic powder. The oxygen and metallic powder are mixed in the pipe and carried through the pipe to the material being pierced or cut. This mixture is ignited at the end of the iron pipe, producing an extremely high-temperature reaction that melts concrete and other non-ferrous and ferrous materials in its path. **Linde Co., Division of Union Carbide Corp., CE-11, 270 Park Avenue, New York 17, N. Y.**

Jet Spray Roofing Method

A cost-saving method of applying roofing to flat and free-form surfaces has been announced. The Sealsit gun jet installs roofing via the spray method in a single time-saving operation rather than by the conventional method of building up layers of roofing. A three-man crew using the gun can install between 15 and 18 thousand sq ft of material a day compared to only eight thousand sq ft with a five-man crew utilizing conventional methods.

In the Monoform System, the gun is used to apply asphalt or other materials and glass fibers simultaneously, resulting in a single monolithic film. Besides the roofing industry, the Monoform System is adaptable to serving large markets in construction, industry and agriculture. It can be used in the application of sidewalls or insulation; for maintenance and repair, sound deadening and pipe coating, and as a corrosive protection in water tanks and in waterproofing animal shelters and irrigation ditches. **The Flintkote Co., CE-11, 30 Rockefeller Plaza, New York 20, N. Y.**

Blue Ox-Side Boom

The new Blue Ox-Side Boom has been specifically designed for contractors and gas distributing companies to be used in pipe stringing, lowering-in operations, oil and gas pipeline construction and repair work. Features of the new unit include 4-wheel drive for greater traction, and 4-wheel steering plus independent, or simultaneous, controlled right and left hand brakes to allow the shortest possible turning radius, increasing the vehicle's maneuverability. The vehicle's hydraulically controlled counter weight and special 15 in. frame give it a capacity lift of almost 13,000 lb. High flotation tires permit the vehicle to operate freely on city streets without damage to paved surfaces, walks, curbs, boulevards and landscaping. **FWD Corp., CE-11, Clintonville, Wisc.**

Side Boom

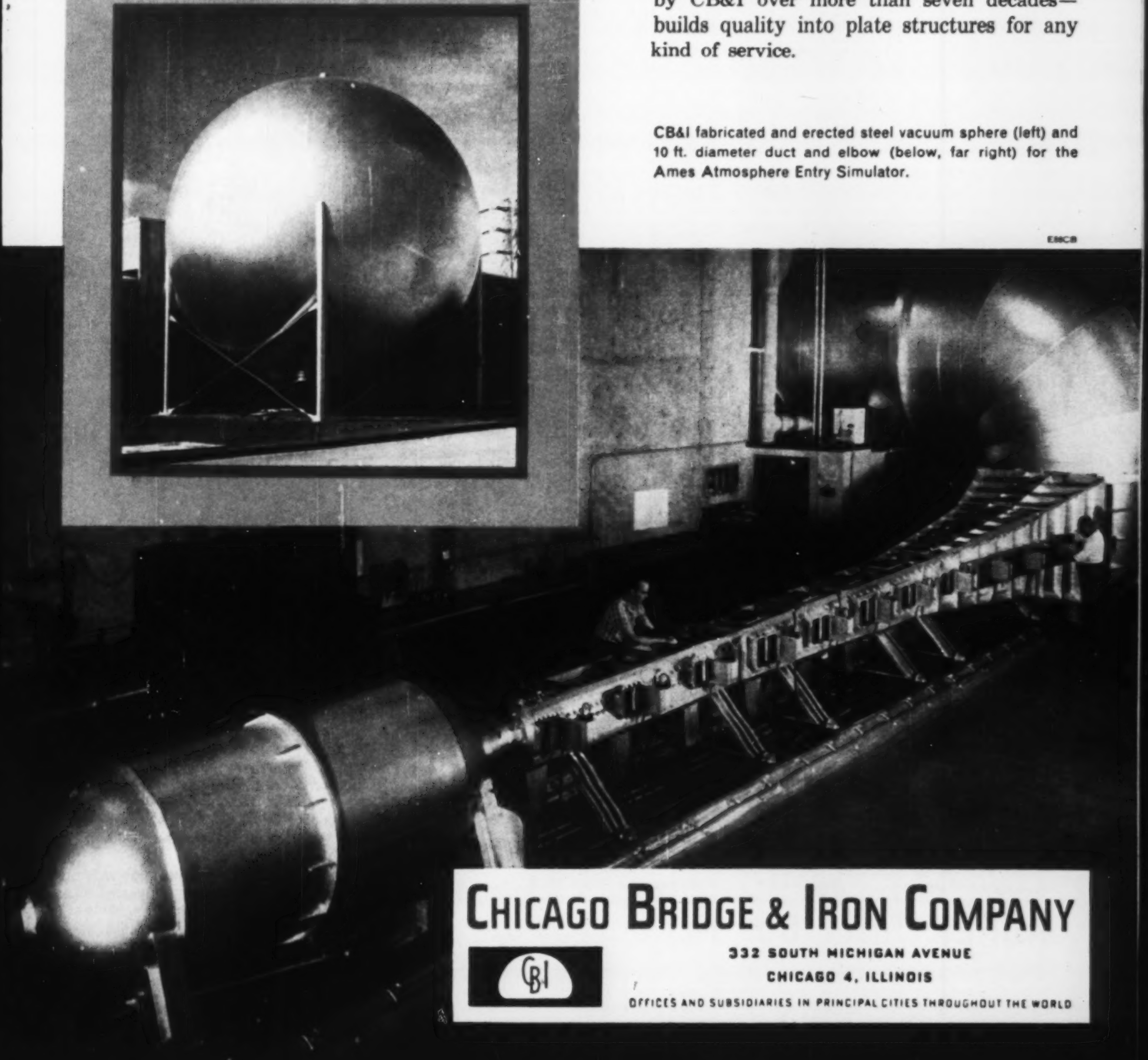
HORTONSPHERE
helps advance
missile technology

The flight of a ballistic missile entering the earth's atmosphere is simulated in an Atmosphere Entry Simulator built by the National Aeronautics and Space Administration at Ames Research Center, Moffett Field, California.

Employing the Ames Simulator, space scientists quickly and economically determine in the laboratory whether a specific design can survive re-entry.

CB&I fabricated and erected several vital components for this important research facility. Included are a 30½ ft. diameter steel vacuum sphere and a 10 ft. diameter duct and elbow.

Craftsmanship in Steel—skillfully developed by CB&I over more than seven decades—builds quality into plate structures for any kind of service.



CB&I fabricated and erected steel vacuum sphere (left) and 10 ft. diameter duct and elbow (below, far right) for the Ames Atmosphere Entry Simulator.

EMCB

CHICAGO BRIDGE & IRON COMPANY

332 SOUTH MICHIGAN AVENUE
CHICAGO 4, ILLINOIS
OFFICES AND SUBSIDIARIES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

EQUIPMENT, MATERIALS and METHODS

(continued)

Street Patcher

THIS "HOT ROLL" STREET PATCHER offers the benefits of heat compaction and sealing plus easy portability: it can be carried on a truck tail gate in a special rack. Powered by a 3½ hp engine, this 600-lb model MP26 features forward and reversing at fingertip control, with a handy clutch for easy stop and go. A 20-lb propane tank fires the 26-in. wide roller for 16 hours. Ruggedly built for the larger patching crews of cities, counties and states, the unit gives permanent patches even on cold, damp days. Also available is the lighter model SP18, weighing 230 lbs. **Ellis Distributing Co., CE-11, Box 168, Liberty, Mo.**

Extra High Lift Tractor Shovel

A SPECIAL HIGH LIFT MODEL industrial tractor shovel has been developed to meet bulk handling situations in which extra high dumping, such as into high bed road trucks, large containers or foundry sand mullers, is required. The new units provide a full 7 ft 2 in. of dumping clearance. High dumping clearance has been accomplished with no sacrifice to the unit's digging capacity, full-load, 45-deg bucket tip-back carry position and overall speed of operation. Capacity of the tractor shovel is 1600 lb. The angle of dump with the higher bucket is 43 deg. Longer bucket arms to increase the height provide a maximum reach of 42 in. achieved with the bucket at a height of 53 in. The special tractor shovel units can be provided with a full range of buckets from 12 to 27 cu ft capacity. **The Yale & Towne Manufacturing Co., CE-11, 11,000 Roosevelt Blvd., Philadelphia 15, Pa.**

Break-Resistant Blades

THE MR 926, a new addition to the line of Blue Bond Break-Resistant abrasive blades, features Leno-Weave fiber glass reinforcing, a patented manufacturing process that weaves layers of tough, flexible glass cloth into each blade. Silicon Carbide particles flow through the reinforcing mesh, protruding beyond its surface. This protects the fiber glass cloth from becoming thin from side wear. The original break-resistant qualities are maintained through the entire life of the blade.

The MR 926 was especially developed for use on extremely abrasive materials such as: concrete block; a wide range of refractories including first quality medium to high alumina, mullite, sillmanite, basics and even certain super duty brick; building materials such as sandstone, precast units and certain asbestos cement products. It is available in 14, 18 and 20-in. blades. **The Clipper Mfg. Co., CE-11, 2800 Warwick, Suite 123, Kansas City 8, Mo.**

Mobile Welder

THE "WELDMOBILE" IS A self-contained, self-propelled welding unit, with engine directly coupled to the generator, not a tractor with a generator driven through power take-off. The larger wheels in the rear with Ground Gripper tires, the implement type tires in the front, and the greatly increased ground clearance at both axles have improved its mobility over that of previous models.

Self-Contained Unit

The unit is designed to provide a mobile self-propelled unit for installations in which welding applications occur at widely separate points. By traveling directly to the job and being ready to weld without waiting for electricians to hook up power lines, the unit saves hours of time. Since its towing capacity is rated at 2,000 lb draw-bar pull, it can tow other equipment or material to the job.

The 400-amp model is powered by a 6-cylinder industrial engine, and the 600-amp model is powered by a V8-cylinder industrial engine. In addition to welding power, the Weldmobile can supply up to one kw (110 v DC) auxiliary power for operating lights and electric motor powered equipment.

Two wells and brackets are located at the rear for acetylene and oxygen tanks. Welding, traveling and power controls are centrally located in front of the driver's seat on a special dashboard. **Hobart Brothers Co., CE-11, Troy, Ohio.**

NEW PORTABLE PAVEMENT DRILL BY ACKER

SPEEDS HIGHWAY CORE TESTING

65 CORES A DAY WITH HIGH SPEED ACKER DIAMOND BIT

- Full 360° angle drilling
- Hydraulically operated leveling jacks
- Adjustable core barrel guide
- Integral pump and 100 gallon water tank

In routine operation, Acker's new highway test core drill using special Acker thin-wall diamond bits is producing 65 or more quality test cores per 8 hour shift.

Trailer mounted for portability, this new rig features a 100 gallon water tank and pump; a new built-in core barrel guide that saves time; hydraulic leveling jacks that simultaneously level the rig regardless of road contour; and dozens of valuable, exclusive features.

Write today for Bulletin 32CE;

ACKER DRILL CO., Inc. P.O. BOX 830
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Over 40 years of experience manufacturing a complete line of diamond and shot core drills, accessories and equipment.

JOB REPORT: *NELSON Stud Shear Connectors in Composite Construction*

COMPOSITE *STEEL-CONCRETE* CONSTRUCTION...

in the new Pfizer Medical Research Laboratories

Composite construction saved 20% on steel tonnage in this modern three-story research facility which consolidates many scientific disciplines in the search for new drugs to advance better health and lengthen man's life span. According to consulting structural engineers, Garfinkel and Marenberg, by using lighter, shallower steel beams, more space was provided for the passage of piping and duct work, while minimum depth of floor construction was maintained.

Nelson stud shear connectors were welded to the top flanges of the steel floor beams and were then embedded in the concrete floor slab. Once the concrete set, the shear connectors transferred horizontal shearing forces from the beam to the concrete slab... causing the concrete and steel elements to function as a unit.

Composite construction can provide these economies and advantages for your next job... *shallower beams* to meet equal load requirements • *provide the same usable cubic area* with less building materials • *longer spans* for greater load-carrying capacity per pound of steel • *wider spacing of columns* for more unobstructed floor space.

For complete information, call in your local Nelson Field Man, or write for "Composite Construction for Buildings", Nelson Stud Welding, Division of GREGORY INDUSTRIES, INC., Dept. 10, Lorain, Ohio.

Pfizer Medical Research Laboratories, Groton, Connecticut. Architects: Shreve, Lamb and Harmon Associates • **Structural Engineers:** Garfinkel and Marenberg • **General Contractor:** W. J. Barney Corporation — all of New York City • **Structural Steel Contractor:** Elizabeth Iron Works, Elizabeth, N. J.

NELSON Stud Shear Connectors *are approved by AASHO for bridge construction.*

FOR BETTER CONSTRUCTION Steel

NELSON STUD WELDING

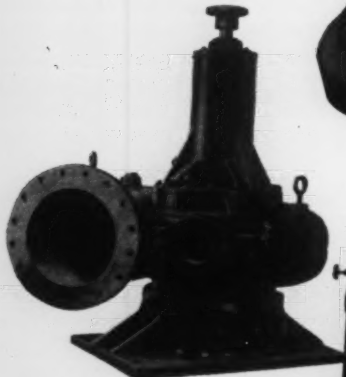
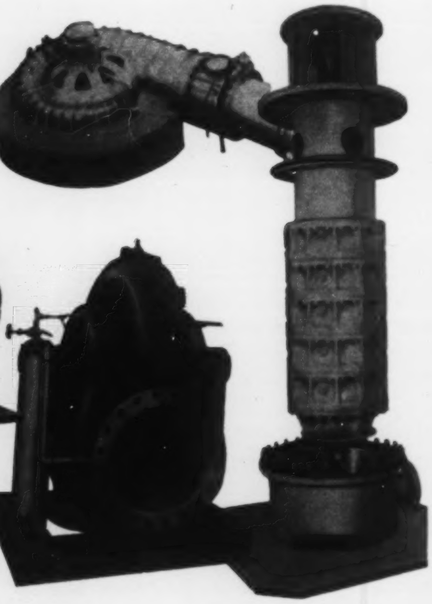
Division of GREGORY INDUSTRIES, INC.

Manufacturers of... Nelson Stud Welding Products • Nelson Bulldog Concrete Fastening Products • Nelson Powder-Actuated Fastening Tools

Tidegate Repair

AFTER A YEAR OF PUNISHMENT from flood waters and industrial waste in Jersey City's new sewerage system, Epoxy resin repairs on the sewer tidegate remain 100% leak tight. Jersey City's system uses the check valve principle to regulate pressures caused by storm conditions or high tide. A swinging-door type cast iron tidegate, 48 in. in dia and weighing about half a ton, opens or closes to equalize pressures. During storms it opens to release excess storm water into Newark Bay. At high tide it prevents tide water from entering the system. In either situation, wear and tear is considerable: from water pressure, from abrasive action by objects floating on the water on both sides of the tidegate, and from corrosive action by the chemicals and wastes prevalent in the highly industrialized area.

Previously, the Jersey City Sewerage Authority relied on rubber gaskets to keep the tidegate leak proof at all times. But the gaskets tended to erode rapidly and were subject to distortion when water movement became turbulent. When leakage caused by several worn areas in the gaskets appeared a year ago, Metalset A-4, a metallic epoxy resin compound was used on an experimental basis. Small amounts of Metalset were applied to the leaking areas. The repair job was done by three men in approximately six working hours. This was in November 1959; after one year, the original Metalset repairs remain completely leak tight. **Smooth-On Mfg. Co., CE-11, Jersey City, N. J.**

SPEAKING OF PUMPS!

Specifying or buying pumps is a big responsibility. You must be sure the pump you select will operate efficiently, economically and dependably "around-the-clock" or in emergencies.

C. H. Wheeler can help you! We make the type pump you need—centrifugal, mixed or axial flow, both horizontal and vertical—in a wide range of capacities and heads.

Also, we can assist you in designing your pump installation, whether it be for municipal or industrial water supply, sewage, drainage, irrigation, flood control, fire protection, heating, air conditioning, or steam power plant services.

We've been designing and manufacturing quality pumps for almost three quarters of a century, so you know when you specify or buy C. H. Wheeler pumps, you can depend on them. Consult your local representative or write for more information.

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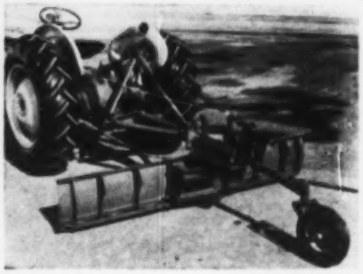
Centrifugal, Axial and Mixed Flow Pumps • Steam Condensers • Steam Jet Vacuum Equipment • Marine Auxiliary Machinery • Nuclear Components

Earth-Moving Attachment

A NEW EARTH-MOVING implement has weight and capacity to match the performance potential of newer models of tractors. The heavy duty rear-attached adjustable blade is available in sizes of 6 and 8 ft.



Heavy-duty blade

With frame members built of rugged steel tubing and with the blade reinforced throughout its length by an extra member of shaped heavy steel plate, the new implement is said to handle such heavy scraping and backfilling jobs as road grading and earth removal with ease. It can be attached readily to all tractors with Categories I and II 3-point implement linkage systems, and features a wide range of adjustments, many of which can be made from the tractor seat. The blade can be angled, offset or tilted for a wide range of earth-moving operations. **Tractor & Implement Div., Ford Motor Co., CE-11, Birmingham, Mich.**

"Hey, Hartley—
it's the white pipe again.
No need to rod!"
MEN WORKING

Right! There's no rodding necessary because roots just can't get in and clog up Transite®, *the white sewer pipe.* Johns-Manville's patented Ring-Tite® Joint keeps out even the thirstiest of these system disrupters. And it remains impenetrable for the duration of the line. Remember, by keeping roots out you eliminate the major cause of expensive periodic cleanouts . . . an expense which can run over $2,000 annually per mile of pipe in a system having joints that are not tight.

Actually, Transite starts saving you money from the very beginning. Its long length and light weight make this asbestos-cement pipe easy to handle in trucking, moving and lowering into the trench. Once in the trench, Transite adjusts easily and speedily to accurate line and grade. And that Ring-Tite coupling makes a dependable joint quickly and effortlessly. You'll save on operation costs too, because Transite's low coefficient of friction ($n = 0.010$) means faster flow and shallower trenches.

Hartley knows what he's talking about when he says that Transite can cut *your* sewer system costs. Get all the details on Transite, the white sewer pipe. Write Johns-Manville, Box 14, CE-2, New York 16, New York. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE
TRANSITE PIPE
JM

New Computer Model

A NEW MODEL OF THE IBM 1401 Data Processing System, with tape units of intermediate speed, lowers tape system operating costs. Designated the IBM 1401 E, the system is designed for users who would like to convert from punched cards to tape, but do not require high speed tape systems. Key component of the 1401 E is the new, low-cost IBM 7330 Magnetic Tape Unit. In a typical system, the 7330 will read data up to 20 times faster and write out results at more than 60 times the rate of punched card equipment. This results in substantially greater systems throughput than is possible with punched card installations.

The new system is expected to extend the use of magnetic tape to medium-size organizations now using punched card systems. The basic difference between the 1401 E and other 1401 models is a tape control unit contained in the central processing unit of the model E, which permits the connection of up to six 7330's to the system.

Major features of the 7330 include: complete tape code compatibility with IBM 727 and 729 magnetic tape units, dual-density reading and writing speeds of 7,200 and 20,000 characters a second, and full interchangeability of tapes with all other IBM units. **International Business Machines Corp., Data Processing Division, CE-11, 112 East Post Road, White Plains, N. Y.**

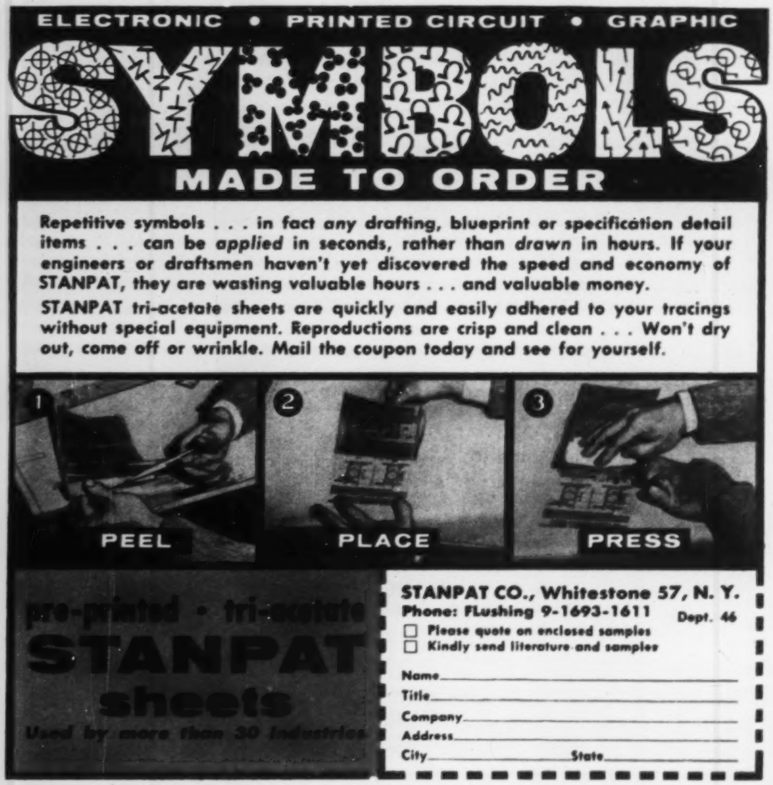
Universal Joint

A NEW 4-PIECE universal joint which permits perforated drainage pipe sections to be joined at any angle from 0 to 90 deg, right or left, has been developed for use with 6-in. diameter Hel-Cor perforated subdrainage pipe.

Band-Ell sections are interlocked and fastened to pipe ends with either bolts or wedge fasteners, after which the desired angle can be attained by varying the location of the flanges in relation to the top of the pipe. This universal joint remains tight through earth shifts, frost upheavals and heavy flow. Thus, the joint is particularly helpful to the contractor since it enables him to adapt his subdrainage pipe to meet existing topographic conditions, and permits him to reduce his inventory to a single, all-purpose elbow. **Armco Drainage & Metal Products, Inc., CE-11, 9360 Curtis Street, Middletown, Ohio.**

Crawler Trencher

A NEW CRAWLER MOUNTED Ditch Witch trencher series has been announced. The crawler mounted machines are available in all M series machines in either 9 or 12 hp models. The crawler trenchers are especially suited to applications where traction or flotation is marginal, or where a considerable amount of maneuverability is required. The crawler trencher is completely self-propelled and equipped with a steering device which takes all of the "muscle" out of maneuverability. The trencher has proved well adapted to digging in frost conditions and rocky soil conditions because of the additional weight. It is also an excellent machine for digging foundation footings because of the ease with which it maintains a "straight as an arrow" trench.



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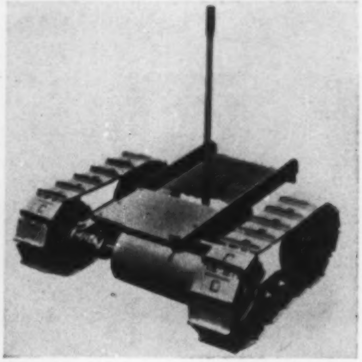


Adapter for Ditch Witch

Ditch Witch is also producing a crawler adapter kit which can be easily mounted to any M-3 series machine produced in 1959 or 1960. It can be attached with five bolts to the frame of the machine, after the removal of the axle and axle bearings. **The Charles Machine Works, Inc., CE-11, Perry, Okla.**

Dual Hitch Automatic Dragline Bucket

THE NEW DUAL HITCH Automatic Dragline Bucket is an all-purpose bucket

(Continued on page 123)

EQUIPMENT MATERIALS and METHODS

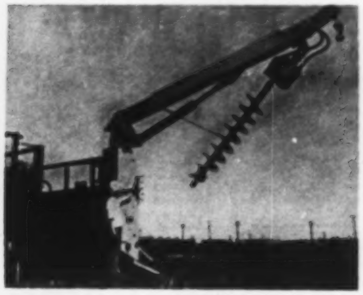
(continued)

that provides the operator of any dragline machine with the ultimate in digging equipment that far surpasses any dragline bucket ever manufactured. This bucket can be readily adjusted in a matter of minutes to dig at any desired depth above or below the fairlead with the same degree of uniform digging efficiency and capacity. **Page Engineering Co., CE-11, Clearing Post Office, Chicago 38, Ill.**

Universal Derrick

A NEW UNIVERSAL TURRET derrick unit with full 360 deg rotation, three mounting positions for line bodies and optional equipment including hydraulic digger and fibreglass one-man basket is now in production.

Known as the Model 8-TTD-30-U, it will mount at right rear, left rear or behind the cab in only 16 in. of space. All controls are unitized into the base, giving the operator full visibility and fast response of controls from one location. Smooth performance is achieved by full hydraulic action.



Turret Derrick Unit

Box type heavy duty steel booms telescope in two sections to give a 21½ ft extended working radius through a 360 deg arch range. Maximum capacity is rated safely at 8,000 lb. Stability is achieved through hydraulic outriggers and jacks.

A special engineering feature is in the versatility of the hydraulic digger unit. The operator may stow and unstow the auger automatically and use the digger with either boom section, making possible maximum radius for digging holes, yet enabling the operator to stow the digger with the main boom section while lifting and setting large utility poles with no danger to derrick, pole, digger or personnel. **Truco/Denver, CE-11, 3963 Walnut St., Denver 5, Colo.**

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FOR HIGHER STRENGTH . .
GREATER DURABILITY, MINIMUM SHRINKAGE
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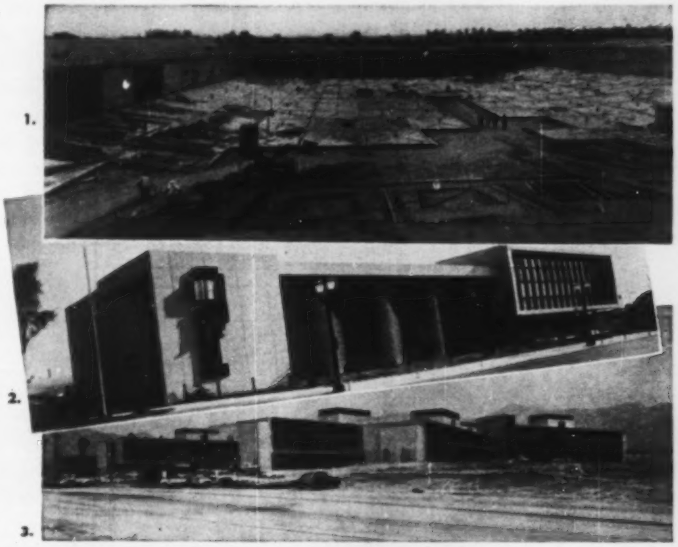
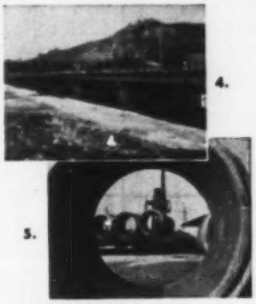


1. *Ontario Reservoir, Ontario, California.*
2. *Glendale County Courts Building, Glendale, California.*
3. *University of California at Riverside, Residence Hall Units 1, 2 and 3, Riverside, California.*



4. *Mission Boulevard Pre-Stressed California State Highway Bridge, Riverside, California.*
5. *Concrete Pipe Manufactured by F. Hurlbut Co., Green Bay, Wisconsin.*

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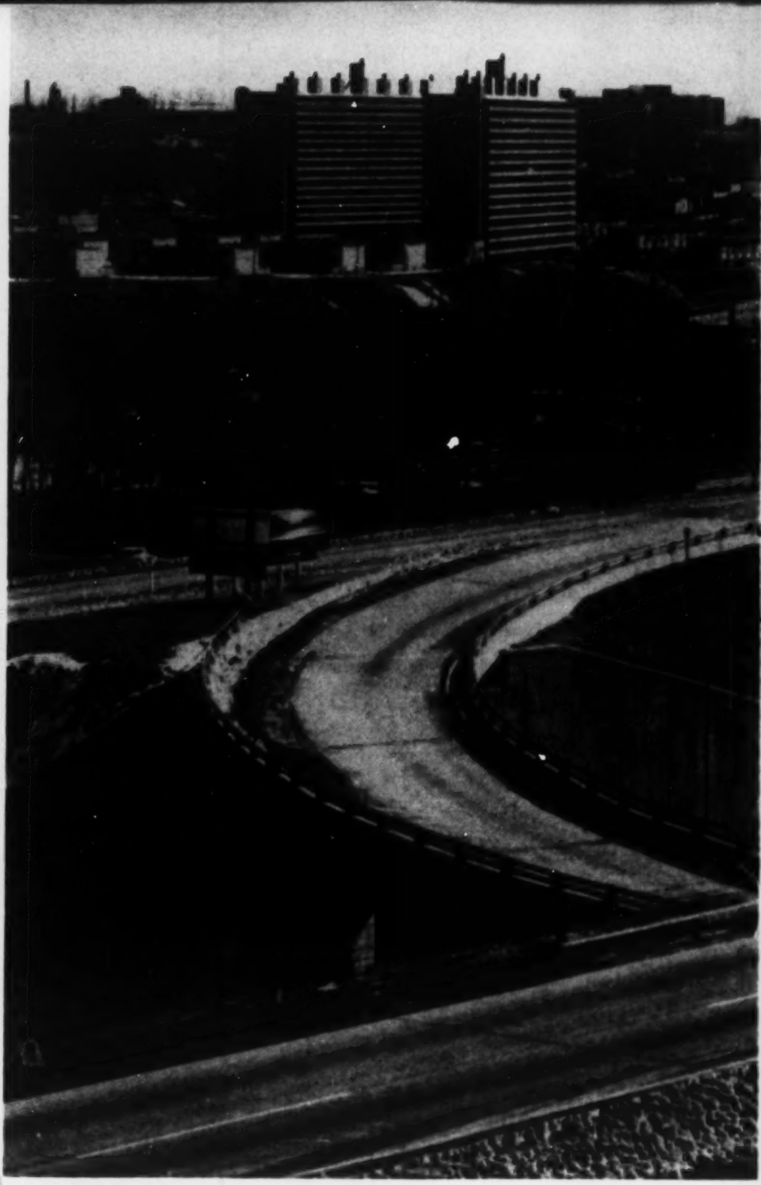

Only steel could do this job. City Line Avenue Interchange on Schuylkill Expressway includes seven grade separations on three different levels—an outstanding engineering job costing $3,000,000 to construct. Michael Baker, Jr., Inc. was responsible in total, for the design of approximately 50 million dollars worth of the Schuylkill Expressway project.

Short-span bridge over Pennsylvania Turnpike at Norristown, Pa., designed in steel for fast erection and low cost.

Mr. Michael Baker, Jr. at far right, discusses the Schuylkill Expressway—City Line Avenue Interchange at Philadelphia that his company designed with USS Structural Carbon Steel. Other men include Joseph Mundo, Wayne H. Meyers, C. V. Knudsen, Robert L. John and C. F. Eben, Jr.

5000 bridges designed

at Michael Baker, Jr., Inc. Consulting

Michael Baker, Jr. of Rochester, Pennsylvania, heads one of the country's largest firms of consulting engineers. Since 1944, his organization has designed about 5000 bridges—five for every mile of highway they've worked on—and 98 per cent of them are steel!

In designing bridges, engineers must think of strength, safety and economy, as well as flexibility for the future—and when they think of these things, they think of steel, says Mr. Baker.

The ever-increasing stream of traffic on the highways makes it important to design bridges that can be expanded to handle this increase, yet the investment is so great that the basic structure must be good for 50 years

98% are in Steel

Engineers, Rochester, Pa.

or more. Steel structures fill both requirements well.

If a steel bridge must be demolished, in connection with the reconstruction of a roadway, the steel itself can be salvaged and used in the new structure. On low-cost jobs, this salvage feature is a most important one.

These are just a few of the reasons why steel should be used for short-span bridges. You can confidently design in steel—the material you know best, the material that offers most—knowing it will be available. For more information on the USS Structural Carbon Steels and High Strength Steels designed for bridges, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS, MAN-TEN, TRI-TEN and "T-1" are registered trademarks

USS Steel for bridge design

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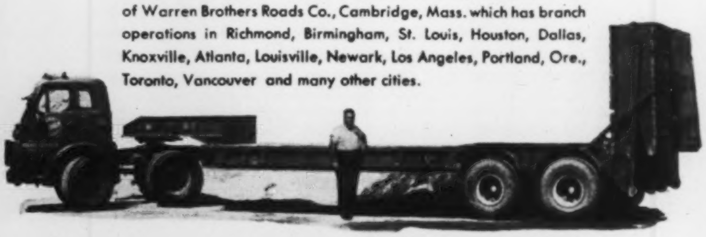
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company
United States Steel

New BIRMINGHAM Lowbed inspected by Dist. Supt. Ralph Johnson of Warren Brothers Roads Co., Cambridge, Mass. which has branch operations in Richmond, Birmingham, St. Louis, Houston, Dallas, Knoxville, Atlanta, Louisville, Newark, Los Angeles, Portland, Ore., Toronto, Vancouver and many other cities.



WARREN BROTHERS ROADS Co., likes BIRMINGHAM lowbeds

"One of our BIRMINGHAM Lowbeds has been in continuous service 14 years," states Mr. Johnson, "and it is one of the best investments we ever made. It still is good for many more years service."

The new BIRMINGHAM Lowbed shown above is a 40-ton trailer with hydraulic ramps which provide easy loading and hauling of pavers from job to job. Warren Brothers is a national organization which builds streets, highways, airfields, etc., specializing in asphalt paving.

(Write for BIRMINGHAM Trailer Catalog)

BIRMINGHAM MANUFACTURING COMPANY, Inc.

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PLATFORMS TOTEM-ALLS LOWBEDS

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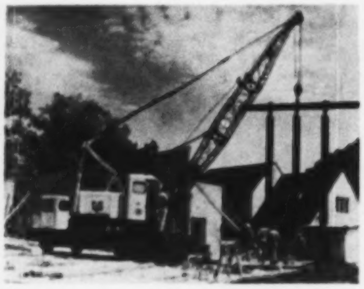
EQUIPMENT MATERIALS and METHODS

(continued)

Truck Crane

A NEW 20-TON CAPACITY truck crane has been developed which can handle boom lengths 40% longer than other machines in its weight or price category. Technically labeled a P&H Model 255B-TC truck crane, it is said to safely handle booms and jib extensions up to 140 ft in length. It has proved capable of delivering a 5,500-lb load 12 stories above ground, or positioning 4,300-lb loads 60 ft away. The main gear housing is built as an integral part of the machine. All major gears in the crane portion of the unit are sealed inside to deliver maximum efficiency, yet remain trouble-proof from a maintenance standpoint. The gears require change of oil only once a year.



20-Ton Capacity

Convenient removal of certain components automatically provides an axle weight distribution as acceptable as most 15-ton truck cranes on the highways of any state. Maximum highway speed is reported to be 40 mph.

The unit can be readily equipped with a dragline bucket, clamshell bucket, or pile driver—all using the standard 40-ft boom used for hoisting work. The front-end crane attachment can be quickly replaced with a backhoe attachment which digs to depths in excess of 21 ft. A shovel attachment is also available. **Harnischfeger Corp., CE-11, 4444 W. National Ave., Milwaukee 16, Wis.**

Portable Sandblasting

DESIGNED FOR USE THROUGHOUT industry where fast, economical sandblasting is necessary for a multitude of different applications, the new portable sandblasting unit requires no more air than a production spray gun.

The "Handi-Blast" Portable Sandblaster will quickly clean dried cement, rust, dirt or paint from Ready-Mix trucks

(Continued on page 128)

NEWPORT NEWS HARNESSES 12,000,000 HORSES...

Since 1921 the total rated output of turbine contracts received by Newport News exceeds 12,000,000 horsepower. The Niagara Project, Grand Coulee, Hoover and Chief Joseph are but a few of the installations for which Newport News has designed and built such equipment as hydraulic turbines, valves, gates and penstocks.

Newport News has the men . . . the methods . . . and the machines to take gigantic jobs like these in stride. Large engineering and design staffs, hundreds of highly skilled workmen, five huge machine shops, a pattern shop and acres of foundries are perfectly integrated to produce large units in the shortest possible time . . . from water power equipment to wind tunnels, from cracking towers to paper dryer rolls.

Look to Newport News with its seventy-five years of metal fabricating experience. Your inquiries are invited.

Newport News
SHIPBUILDING AND DRY DOCK CO.
NEWPORT NEWS, VIRGINIA

and construction equipment, leaving a clean, dry, etched surface that provides an excellent bond for new paint.

The manufacturer states that it is the only sandblaster that is completely portable. The over-all height of the unit is 12 in. with a tank diameter of 7 in. The unit weight is 23 lb empty and has an abrasive capacity of 30 lb sand.

Distinctive features of the new unit: built-in sand funnel; automatic opening and closing filler valve; specially designed "Vari-flow" air operating valve that has positions to exhaust tank, shut off, pressurize tank only with a range of blasting air velocity that maintains a balanced tank pressure; fully adjustable sand flow valve, designed for long life. **Handi-Blast Div., Hamill Manufacturing Co., Inc., CE-11, Washington, Mich.**

Wheel Traxcavator

THE THIRD IN LINE of wheel Traxcavators to be introduced this work season is the 80 net hp 922. In overall design and configuration, the 922 closely resembles the two larger machines previously announced, the 105 hp 944 and the 140 hp 966. The 922 has a 1¼ cu yd capacity bucket and is powered by either a gasoline or diesel engine. The operator's compartment is open and easily accessible, and all loader mechanisms are completely ahead of the compartment.

80 net hp

With a maximum lift capability of 12 ft 2 in. and a dumping reach of 25¾ in., the 922 has a breakout force of 13,700 lb. Turning radius at the outside rear tire is 20 ft 4 in. Ground clearance is 14⅝ in. The D320 diesel engine has 4 cylinders and a 4 x 5 bore and stroke. Maximum rating of this engine is 105 hp. The gasoline engine has 6 cylinders and a 4 x 4⅝ bore and stroke, and starts with a 12 v direct electric system. A 24 v system is standard for the diesel engine with a gasoline starting engine as optional equipment. There is a 2-speed power shift transmission, a torque converter, auxiliary transmission and a planetary final drive. A 4-wheel drive is used for working conditions and a 2-wheel drive is available for roading. The wheel Traxcavator has 4 speeds forward and 4 in reverse. It also has 3 brake controls: the left brake pedal stops the machine and automatically shifts the transmission into neutral; the right pedal serves only as a brake; a parking brake locks the transmission output shaft and automatically shifts the forward-reverse lever into neutral. The 922 has a top speed of 19 mph forward and 24 mph in reverse. **Caterpillar Tractor Co., CE-11, Peoria, Ill.**

Unusual Paving Features

HINGED SHEETS OF WELDED WIRE fabric and "automated" sub-grade sprinkling are the unusual construction features of an 8-mile stretch of 4-lane divided highway north of Monticello, N. Y., forming part of a relocated, re-aligned state Route 17.

(Continued on page 130)

The Good Samaritan

We lay no claim to exclusive virtue, nor any patent rights on high moral principles. But we humbly endorse the "Golden Rule" because we have seen the effects of its application to our own business.

Years ago as a struggling new foundry, M & H designed and made a better valve and hydrant. Then, and many times since then, we received most valuable help and encouragement from water works men, engineers and public officials. From the beginning, service-to-the-customer was an M & H watchword. But the reverse—customer-service to the Company—voluntarily and without obligation, surely was a practical application of the "Golden Rule."

These customer "good Samaritans" have stayed with us through the years. They have given us many a lift along the road down which has come today's product. Engineering and foundry research has proved many of their suggestions worthy of adoption—thus helping us to design and manufacture the world's best valve and hydrant.

This customer good-will has been, and is, a human and inspiring phase of M & H steady growth into a position of leadership in the water works industry.

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Of special interest to engineers is PCA's new booklet, "*Elementary Analysis of Hyperbolic Paraboloid Shells.*" It's an authoritative presentation of design fundamentals and HP geometry. Design data are included for standard, skewed, groined and sloping HP's. For your free copy, fill out coupon and mail to nearest PCA district office listed below. (U.S. and Canada only.)

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WASHINGTON 4, D.C., 837 National Press Bldg.

Principal advantages of the hinged sheets lie in shipping and handling. The reinforcing ability of the sheet is not affected by the hinges. But because the sheet folds almost in half, the shipping width is reduced from nearly 12 ft to about 7 ft, permitting delivery on flat bed trucks directly from plant to stock piles on the job sites. Placement of the hinged sheets is readily handled by two workers. The two men lose no time and have no difficulty in placing and unfolding the hinged sheets as soon as the strike-off screed has evened the first course of concrete.

The sub-grade sprinkling device consists of a perforated pipe extending across the 12-ft forms, at the leading edge of and at right angles to the first paver in the train. Each time the paver moves forward, after having deposited concrete for the first 6½-in. course, the operator opens the sprinkler valve, and a fine 12-ft wide spray of water evenly wets the entire subgrade, just ahead of the previously placed concrete. **Wire Reinforcement Institute, Inc., CE-11, National Press Building, Washington 4, D. C.**

Long Lasting Wheel Tread

SELECTION OF SNOW REMOVAL EQUIPMENT is an important item for the Ohio Turnpike Commission. With nearly 2,000 lane miles of highway to maintain, the choice of snow plow wheels has been particularly difficult. On heavy-duty equipment currently in use, a 2,400 lb plow blade assembly rides directly on two 10-in. caster wheels. High speed plowing operations over long distances, in a corrosive brine of ice removal chemicals, have resulted in constant wheel replacement and equipment downtime.

Utilizing standard components, the Commission has originated a unique wheel design that successfully seals contaminants out and solves the problem of corrosion. For a solution to wear-resistance of tire tread materials, the Commission found that "Duralast," a polyurethane compound developed especially for applications requiring heavy load-carrying capacities and long wear, would deliver up to 5,000 miles of service or more. Additional advantages of Duralast are its quieter running and shock absorbing features. These qualities add substantially to the life of the other equipment as well. **The Hamilton Caster & Mfg. Co., CE-11, Hamilton, Ohio.**

Hydraulic Derrick

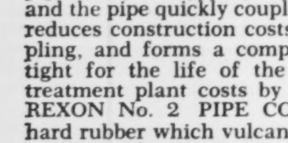
A NEW VERSATILE Hydraulic Derrick is now available for either front or rear mounting. It is the only derrick currently available for front installation which has lateral movement, allowing it to reach 9 ft to either side from center line of truck chassis. It also has fore and aft, up and down movements. This wide range of movements makes it possible to park parallel with the curb and completely plumb any pole without the use of a pike. Adjustable side legs simplify the digging of anchor holes with minimum of truck maneuvering. Sheave heights of 25-27-29 ft are provided, and allowance of an additional 2 ft to each of these sheave heights is provided by a single extension of the side legs.

The derrick is designed to go to the

(Continued on page 132)

Leak-proof "for the life of the line"...

TYLOX Rubber PIPE GASKETS



Heavy-duty, acid-resistant, *flexible* TYLOX Gaskets are made for large bore tongue and groove pipe. They are quickly "snapped on" to the pipe, and the pipe quickly coupled into the line. TYLOX reduces construction costs by speeding pipe coupling, and forms a compression seal that stays tight for the life of the pipe. TYLOX reduces treatment plant costs by preventing infiltration. REXON No. 2 PIPE COATING is a synthetic hard rubber which vulcanizes to pipe by catalytic action, *not* by evaporation which causes pin-holes. REXON No. 2 protects concrete pipe from deterioration by hydrogen sulphide gas, oils, greases and solvents. WRITE FOR MORE DETAILS.

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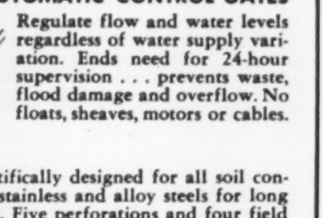

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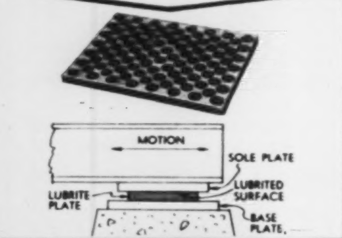

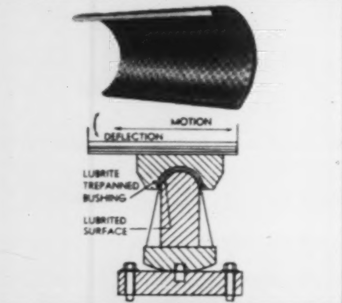

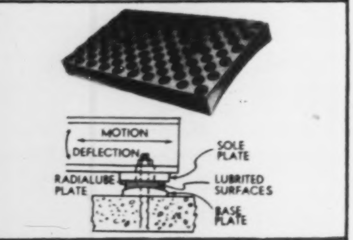

When expansion, contraction and/or rotation of structural members are factors in the design of any bridge, overpass, building or other construction, Lubrite offers many distinct and important advantages. Specifically Lubrite permits the use of simplified designs, cuts construction costs substantially, virtually eliminates maintenance and offers a low coefficient of friction. Assure better results, longer life and unequalled performance — specify Lubrite — over 50 years of success "where others have failed"

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EQUIPMENT, MATERIALS and METHODS

(continued)

ground and apply 3,000 to 4,500 lb down pressure on derrick supported digger. It has a lifting capacity from 2,500 lb with sheave at ground level to 12,500 lb at max elevation. It will body load 8,500 lb and handle side reach position loads up to 3,500 lb with a safety factor in all three positions. Boost rams elevate the mounting platform. The control valve operating these boost cylinders automatically controls the main cylinder. Each side leg cylinder is operated by a separate valve and these cylinders are an integral part of each leg. **Utility Body Co., CE-11, 1530 Wood Street, Oakland 7, Calif.**

Electronic Surveying System

An Electrotape electronic distance-measuring system, a small surveying crew and a helicopter are slashing days and weeks off a project to establish microwave stations along a 1400-mi Pacific Gas and Electric pipeline. The new pipeline will stretch from San Francisco to British Columbia, running through Oregon, Washington and Idaho.

Electrotape determines the location of the microwave stations by measuring distances between the proposed sites on the route and attenuation of a microwave signal over the distances spanned. Consisting of two identical, portable, tripod-mounted transmitter-receiver units, Electrotape is capable of measuring miles in minutes. Any distance from 250 ft to more than 60 mi can be measured as the system automatically computes the time taken for a microwave signal to travel from one unit to the other and back. The time measurement is read out directly in digital form to the nearest twentieth of a millimicrosecond. This figure is easily converted into precise linear distances of inches, feet, yards, miles or metric units. As many as 300 mi have been charted in a single day. **Cubic Corp., CE-11, San Diego 11, Calif.**

Offshore Radar Plotter

Accurate navigational control of offshore survey vessels can be obtained at relatively modest cost through the use of radar coupled with the No. 425 Precision Radar Plotter. This system may be adapted to any radar which has a mechanical sweep control on the back of the display tube.

A continuous plot of the track of a survey vessel is provided as well as digital presentation of precision range to known targets. The operational accuracy for a spot location at a range of 20 mi is ±50 ft; for continuous surveying is ±100-200 ft at the same range. **Alpine Geophysical Associates, Inc., CE-11, 10 Oak Street, Norwood, N. J.**

Vertical Split Case Pumps

Reduced space requirements for the new line of OJV and OMV Vertical Split Case Pumps makes them ideal for applications where extreme compactness is of prime importance. The case is split parallel with the impeller shaft with the suction and discharge flanges integral in the vertical base section. The rotating unit is removed easily for inspection or maintenance without disturbing the suction or discharge piping connections. Perfect bearing alignment is achieved with in-line boring with top half of case in position. Double suction impellers are hydraulically and dynamically balanced for smooth quiet operations. Ideal for handling high capacities at medium to high heads and continuous operations, these pumps are used on applications such as marine services, municipal water service, industrial water service, booster service, cooling towers, fuel service, circulating and boiler feed. Capacities range to 6000 GPM and heads to 380 ft. **Aurora Pump Division, The New York Air Brake Co., CE-11, Aurora, Illinois.**

Vertical Compactness

New Lettering Pencil

A new lettering pencil, the "Leroy 020" Lettering Pencil, is designed to operate with the Leroy Scriber. Uniformity of line width is assured by a new, very thin lead with a diameter of a 0.020-in. pencil point. The lead can be advanced by turning the pencil while it is in the scriber, thus permitting uninterrupted lettering. **Keuffel & Esser Co., CE-11, Third & Adams Streets, Hoboken, N. J.**

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County Road Construction—The story of one county's solution to its road maintenance problems via the introduction of a planned program of soil-cement construction is told in a new sound-color movie titled "A County Builds Soil-Cement." The 20-min film tells the story of a county engineer who is plagued with the problem of maintaining old roads on a limited budget, and demonstrates how he institutes a sound highway planning program. Soil-Cement construction is illustrated in a non-technical manner, with brief descriptions of the nature of this paving material. **Portland Cement Association, CE-11, 33 West Grand Ave., Chicago 10, Ill.**

"Look to the TS-360"—A new 15-min full-color movie, "Look to the TS-360," explains the production, operating and mechanical advantages of the new 30 cu yd TS-360 motor scraper without using the everyday "nuts and bolts" approach. The story has been woven around the theme of a contractor designing an all-hydraulic motor scraper to meet his actual field requirements. **Allis-Chalmers Manufacturing Co., Sales Promotion Dept., Tractor Group, CE-11, Box 512, Milwaukee 1, Wis.**

Rotary Air Drilling—The basic principles of rotary air drilling and its application in mining, quarrying and construction are presented in this 20 min film. The Zephyr, Hurricane and Tornado rotary drilling rigs are featured in this presentation. The different procedures of set-up and operation of the equipment are shown and their function described. An action shot of how rock bit drilling is accomplished is shown in a cut-away view. Bit applications for various rock formations and hole size are explained. **Gardner-Denver Co., CE-11, Quincy, Ill.**

American Engineer—This technicolor film shows the spectacular wonders of engineering at its best. Shown in the film are radio telescopes catching "broadcasts" from the sun and stars, petroleum from beneath the ocean, the largest atom smasher in action, the world's longest over-water bridge, and many other triumphs of America's engineers. The 16 mm film runs 29 min, and has an original symphonic score. **The Jam Handy Organization, CE-11, 2821 E. Grand Blvd., Detroit 11, Mich.**

"Water Bill U.S.A."—The all-important subject of water and what we must do to assure a plentiful supply for the future is the basis for a new color motion picture, "Water Bill U.S.A." Narrated by Walter Cronkite, the 27-min long film illustrates the problem and tells how citizens in various parts of the country have solved their problem and what others can do about theirs. **Caterpillar Tractor Co., CE-11, Peoria, Ill.**

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ENGINEER'S VEST-POCKET BOOK—Whether you are looking for the formula for the Binomial Theorem, the properties of structural steel, the strength of gear teeth, the resistance of an immersed body moving through fluid, thermal stress, verniers, cost estimating, or any of the other 250 main items and 47 important charts, you will find the information in this 192-page (2⅝ x 5½) book. There is an alphabetical index, an index of charts and tables, as well as 12 marginal indexed headings. The price is $.90. **Ottenheimer Publishers, Inc., CE-11, 4805 Nelson Avenue, Baltimore 15, Md.**

CRANES—The new 60-ton Moto-Crane Model MC-760 is described in this 12-page catalog. One of the features discussed is the exclusive "Power-Set" outriggers that set up in about one minute. They are designed with special curved beams with attached self-adjusting floats that move out and down simultaneously. Each beam is individually, hydraulically controlled from the carrier cab. Another feature included is a 10-year warranted "Shear-Ball" connection, the huge "ball bearing" design which connects the turntable to the carrier. **Advertising Dept., The Thew Shovel Co., CE-11, Lorain, Ohio.**

DIESEL CRAWLER-TRACTORS—This company's 100 hp diesel crawler-tractor line is described in a colorful 28-page booklet. An important feature of the line is a dry-type air cleaner that is self-cleaning, with an efficiency of more than 99%. There are also completely enclosed brakes, hydraulic track take-up, 17 in. of ground clearance and 14 in. of track oscillation. **The Eimco Corp., Tractor Loader Div., CE-11, 634 South 4th West, Salt Lake City, Utah.**

LONGER CONCRETE FLOOR LIFE—The ability of "Masterplate" concrete floors to last six times longer than ordinary concrete floors is carefully detailed in this new 24-page bulletin. Important features used in the design of any heavily used industrial floors are covered. They include: wear and corrosion resistance, economy, spark resistance, static dissemination, color and non-slip, non-dusting, easy-to-clean surfaces. **The Master Builders Co., CE-11, Cleveland 18, Ohio.**

CONSTRUCTION AND BULK MATERIALS HANDLING EQUIPMENT—A new 4-color catalog contains descriptions and full-color illustrations of this company's tractor shovels, tractor dozers, tractor scrapers, tractor loggers and excavator cranes. Also described is the Clark power train basic to all of these machines. Components pictured are the torque converter, 4-speed power-shift transmission, and steering and non-steering axles. **Construction Machinery Div., Clark Equipment Co., CE-11, Pipestone Plant, Benton Harbor, Mich.**

POLYSULFIDE BUILDING SEALANT COMPOUND SPECIFICATIONS—The first guide to acceptable performance of polysulfide sealing compounds for the building trade has been approved by the American Standards Association. Entitled "American Standards Specification for Polysulfide Base Sealants for the Building Trade," it provides architects, specifiers and contractors with a practical set of yardsticks against which sealing compounds can be measured. It covers application of polysulfides to concrete, aluminum, stainless steel and glass surfaces. **Thiokol Chemical Corp., CE-11, Trenton, N. J.**

CONCRETE ACCESSORIES—Coil loop, standing, coil rod, screw and hold down anchors, threaded inserts and fastening and lifting hardware are described in this 8-page bulletin. Included are illustrations of the various items, as well as design data tables. There is also a discussion of strength and safe loads with a test summary. **Superior Concrete Accessories, Inc., CE-11, 9301 King St., Franklin Park, Ill.**

GRATINGS, FLOORING AND TREADS—A new 16-page catalog gives emphasis to the three basic grating types used in construction. It includes dimensional drawings of more than thirty grating subtypes; eight safeload tables for steel grating, aluminum grating, roadway grating and sidewalk slabs; plus other tables for panel widths, tread widths, floor armor, etc. Various safety treads and nosings are also shown in the catalog as well as detailed instructions for selecting, specifying and ordering grating. **Borden Metal Products Co., CE-11, Green Lane, Elizabeth, N. J.**

DRAGSCRAPER—A new 28-page catalog describes and illustrates DragScraper storage and reclamation. Installation photographs and layout drawings show DragScraper handling of chemicals, ores, sand and other bulk materials. Parts 1 and 2 of the catalog cover outdoor and indoor material handling; Part 3 describes the buckets, blocks, hoists and other components of the machines. **Sauerman Bros., Inc., CE-11, Dept. C-15, 620 S. 28th Avenue, Bellwood, Ill.**

From the MANUFACTURERS

INDUSTRIAL DEVELOPMENTS: The Great Southwest Corp. announces the development of a Great Southwest Industrial District between Fort Worth and Dallas, Texas. Thirty-three companies will operate from there . . . **MERGER:** Nine rock and concrete firms were merged recently into one corporation, Rodeffer Industries, Inc. The companies involved were: six San Gabriel Ready-Mixt Companies, Century Rock Co., Star Rock Products, Inc. and Admixtures, Inc. . . . **CONTRACT AWARDED:** Iraanse Aardolie Raffinage Maatschappij N.V. (Iranian Oil Refining Co.) has awarded a contract worth approximately $5-million to Fluor-Schuytvlot N.V., Haarlem, Holland (a subsidiary of The Fluor Corp., Ltd.) for the design, detailed engineering, purchasing and construction of a U.O.P. Unifier-Platformer to be added to its refinery at Abadan, Iran . . . **EXPANDED PRODUCTION:** Napco Industries, Inc. has expanded its production of universal joints, drive lines and power take-off units, and will now be manufacturing universal joints for use in the farm implement, construction equipment, aircraft and marine fields . . . **EXPANDED FACILITIES:** ESCO Corp. is building a steel service center adjacent to its main plant and offices in Portland, Oregon. ESCO manufactures steel and stainless steel products for the logging, construction, pulp and paper, chemical and other industries . . . A new General Electric Co. plant for the production of Lexan® polycarbonate resins has commenced operation in Mt. Vernon, Indiana . . . **FOREIGN OFFICES:** Prescon of the Pacific, Ltd., has been formed for the fabrication and sale of tendons as used in the Prescon system of post-tensioning prestressed concrete. The new headquarters will be in Honolulu, Hawaii . . . Harnischfeger International Corp., S.A., a subsidiary of Harnischfeger Corp. of Milwaukee, has opened an office in Mexico City to make available technical information on heavy industrial equipment in Mexico and Central America . . . Allis-Chalmers Mfg. Co. has purchased a controlling interest in Etablissements de Constructions Mecaniques de Vendeuvre, S.A., French manufacturer of air-cooled farm tractors, industrial engines, and engine-generator sets . . . **DISTRIBUTORS APPOINTED:** Worthington Corp. announces the appointment of two new distributors: Medico Industries, Inc., Pittston, Pa., to handle the distribution of construction equipment in Pennsylvania, and the Air City Equipment Co., Bellbrook, Ohio, to handle the distribution in that state . . . Distribution of Addex Products for roof maintenance and thin shell concrete roofing in far west and west coast states, has been assigned to the Chemical and Pigment Co. . . . **APPOINTMENTS:** Ivan H. Smith has been named new plant manager for the East Chicago, Ind. plant of Graver Tank & Mfg. Co., a div. of Union Tank Car Co. . . . Joseph W. Greenen has been named General Manager of the World Bestos Div. of The Firestone Tire & Rubber Co., New Castle, Ind. He succeeds Richard A. Riley who was named President of The Firestone Rubber & Latex Products Co., Fall River, Mass. . . . Mel Maddox has joined Allied Materials Corp., Oklahoma City, as manager of the company's Pipeline Coatings and Materials Div. . . . Alvin S. Baer has joined Truscon Laboratories of Detroit as Vice President . . . Robert A. Cook has been appointed Sales Promotion Manager of American-Marietta Co.'s Construction Equipment Div., Milwaukee . . . Jacob O. Whitlock, President of the Midwest Prestressed Concrete Co., Springfield, Ill., has been elected President of the Prestressed Concrete Institute for the coming year . . . The Diamond Iron Works, a div. of Goodman Mfg. Co., has announced the appointment of Eugene C. Herschelman to its Chicago Headquarters Staff . . . Three new management appointments in the Remington Rand Div. of Sperry Rand Corp. have been announced: Robert D. Brown has been named Vice President and General Manager of the Office Machines Div.; Francis V. Bergren has been promoted to Vice President and General Manager of the Systems Div.; Howard V. Widdowes is now attached to the Group Headquarters Staff as Vice President handling special assignments and industry relations.

DRAWING BOARD NEWS No. ①

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Journals: Engineering Mechanics, Power, Soil Mechanics and Foundations, Structural.

2615. Restrained Columns, by Morris Ojalvo. (EM) A method determining the carrying capacity of restrained columns of constant cross section is described. The column failure considered is due to bending about a principal axis of the cross section. The plane of bending is the plane of thrust, applied moments, and restraining moments. The method is applicable when the loads are applied to columns with equal or unequal and eccentricities and cases in which the restraining moments are not linear functions of the end rotations of the columns.

2616. Wind Stresses in Dome, by P. Gondikas and M. G. Salvadori. (EM) Bending stresses due to anti-symmetrical wind pressures in a hemispherical dome elasticically built-in into a cylinder are determined by the Geckeler approach extended to non-symmetrical loads. A numerical comparison with the asymptotic solution of Schwerin indicates satisfactory accuracy of this approximate solution in cases of practical interest.

2617. A Matrix Formulation of the Folded Plate Equations, by A. C. Scordelis. (ST) An analytical procedure, utilizing matrix algebra, is developed for determining longitudinal stresses, transverse moments, and vertical deflections in folded plate structures. The sequence of matrix operations can be programmed for a digital computer having available matrix subroutines. A sequence which has been programmed for the IBM 704 computer is described.

2618. Experience with a Pier-Supported Building over Permafrost, by H. B. Dickens and D. M. Gray. (SM) The construction and performance of a two-story steel frame building over permafrost at Churchill, Manitoba, for 1948 to 1950, is described. Its performance after 9 yr suggests that the concrete pier and spread footing foundation used is a practicable alternative to embedded foundations for large heated structures in permafrost regions.

2619. Bending of Plates on a Viscoelastic Foundation, by K. S. Pister and M. L. Williams. (EM) E. Reissner extended the concept of the classical Winkler-Zimmerman foundation to permit introduction of a differential shear stiffness parameter to the foundation modulus. The resulting system of differential equations of the sixth order is modified, incorporating a different interface condition. The significance of the shear stiffness parameter is examined.

2620. Electrical Energy Analogs of Vibrating Beams, by Frederick L. Ryder. (EM) For the passive-element electrical analog of a finite increment of a beam vibrating in flexure, improvements over the conventional form of the circuit are found by making explicit use of the energy as an analogous parameter in the beams and in the electrical circuit. For a given beam, it is found that these improvements lead to a drastic reduction in the theoretical analog error and in the number of electrical components required per beam increment.

2621. Test of a Riveted Plate Girder with a Thin Web, by D. D. Vasarhelyi, J. C. Taylor, N. C. Vasishth, and C. Y. Yuan. (ST) This paper reports on the buckling and post-buckling behavior of the web and the functioning of flanges at the cover plate cutoffs of a riveted plate girder with a web thinner than specified by AASHO. Results show that buckling of the web does not impair load-carrying capacity.

2622. Elastic Plastic Analysis of Transversely Loaded Plates, by John F. Brotchie. (EM) An elastic, purely-plastic relationship between moment and curvature is assumed; general solutions are developed from small deflection theory for axi-symmetrical yielding over an area and axi-symmetrical yielding along lines. Applications include the inelastic analysis of metal plates, pavement slabs, and continuous plate structures.

2623. Seepage Requirements of Filters and Pervious Bases, by Harry R. Cedergren. (SM) The water-removing capacities of two common but distinctly different types of filter designs are analyzed by the flow-net. Typical solutions and numerical examples emphasize the importance of boundary conditions and permeability upon water-removing capacity.

2624. Dynamic Response of Beams Traversed by Two-Axle Loads, by Robert K. Wen. (EM) The response of beams traversed by two-axle loads is analyzed

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assuming that the dynamic deflection is proportional to the static deflection from the weights of the beams and loads. Numerical results show quasi-resonant effects due to successive applications of loads and wavy beam surfaces.

2625. Mechanics of the Triaxial Test for Soils, by R. M. Haythornethwaite. (SM) The triaxial test analyzed against the background of plastic theory shows the equilibrium conditions and failure criterion as Coulomb's law insufficient to define a unique failure load; a stress-strain relationship is also needed. The problem is solved for an ideally plastic material. Results propose the significance of test data for sands; an alternative yield criterion is suggested on the basis of the test data.

2626. Generalized Solutions for Laterally Loaded Piles, by Hudson Matlock and Lymon C. Reese. (SM) To reach rational solutions for problems of laterally loaded piles, the non-linear force-deformation characteristics of the soil must be considered with repeated application of elastic theory. Soil modulus constants are adjusted for successive trials until satisfactory compatibility is obtained in the structure-pile-soil system. Basic equations and methods of computation are given for both elastic-pile-theory and rigid-pile theory. Several forms of soil modulus variation with depth are considered. Typical solutions are presented with recommendations for their use in design problems.

2627. The Bearing Capacity of Floating Ice Sheets, by G. G. Myerhof. (EM) The collapse of floating ice sheets under load is estimated on the basis of a rigid-plastic plate on an elastic foundation for various loading and boundary conditions. The results are compared with field observations in the operation of ice roads, floating airfields, and some small-scale loading tests.

2628. Membrane Stresses in Hyperboloid Shells of Revolution, by Placido Cicala. (EM) The computation of membrane stresses and corresponding deformations for a hyperboloid shell of revolution under the most general loading is reduced to the evaluation of simple integrals. For determining wind effects, diagrams capable of simplifying computations are presented, and an approximate formula is suggested.

2629. Buckling of One-Storey Frames and Buildings, by John E. Goldberg. (ST) The theory of buckling of plane, one-storey is described and applied to the collapse of rectilinear frames using a generalization of the slope-deflection method. Both the symmetrical and anti-symmetrical or lurching modes of collapse of plane frames are considered. The relation of the buckling of plane frames to the buckling of the complete structure is pointed out, and a theory for the buckling of such space structures is presented. Illustrative examples are included.

2630. Long Span Prestressed Concrete Folded Plate Roofs, by John C. Brough, Jr. and B. H. Stephens, Jr. (ST) The economics of the design and construction of long span prestressed concrete folded plate structures is indicated by including actual construction costs of four roof structures. A simplified design procedure is outlined and a typical case presented. Field experience with construction methods utilized and recommendations for field inspection included are based on the author's observations.

2631. Discussion of Proceedings Paper 1734, 1739, 1743, 1745, 1749. (PO) J. B. Cooke and Torald Mundal on 1734. G. Robert Koch on 1739. John Lowe, III and James P. Growdon on 1743. Allen S. Carey on 1745. Paul Thurber on 1749.

2632. Discussion of Proceedings Paper 2220, 2445, 2453, 2454, 2498. (EM) George W. Housner on 2220. Morris Ojalvo and Ahmet Cakmak on 2445. Hashim H. Hamzawi on 2453. R. J. P. Garden on 2454. O. C. Zienkiewicz on 2498.

2633. Freezing and Thawing Effects on Prestressed Concrete, by M. J. Gutzwiller and F. E. Musleh. (ST) Freeze and thaw tests were conducted on 48 specimens representing strength levels of 5,000 psi and 3,000 psi. Some beams of 5,000 psi strength were post-tensioned throughout the test. Significant improvement in durability resulted from post-tensioning. Post-tensioned concrete specimens of a rich mix showed better durability than unstressed concrete of the same mix or of a leaner mix.

2634. Flow Graphs in Structural Analysis, by Kurt H. Gerstle. (ST) The relation of flow graphs to the analysis of physical systems is presented. The algebra and two methods of solution of these graphs are treated. The setting up and solution of flow graphs is illustrated in terms of several problems from the field of indeterminate structural analysis.

2635. Discussion of Proceedings Paper 1879, 2410, 2428, 2437, 2480, 2544, 2555. (ST) Lawrence P. Johnson, Jr. and Herbert A. Sawyer, Jr. on 1879. K. G. Harding and N. S. Trahair on 2410. Francis E. Swain on 2428. A. A. Eremin on 2437. Eugene Guillard on 2480. Marvin A. Larsen on 2544. Donovan H. Lee on 2555.

2636. Discussion of Proceedings Paper 514, 1937, 2135, 2136, 2211, 2212, 2213, 2292, 2368, 2431, 2501. (SM) D. K. Bleifuss and James P. Hawke on 514. Ivan C. MacFarlane on 1937. B. K. Hough on 2135. W. J. Turnbull and C. I. Mansur on 2136. James F. Shook on 2211. James R. Cass, Jr. on 2212. C. Y. Li on 2213. G. G. Meyerhof on 2292. O. M. Christof Ehrler on 2368. B. K. Hough and A. A. Eremin on 2431. Bobby Ott Hardin on 2501.

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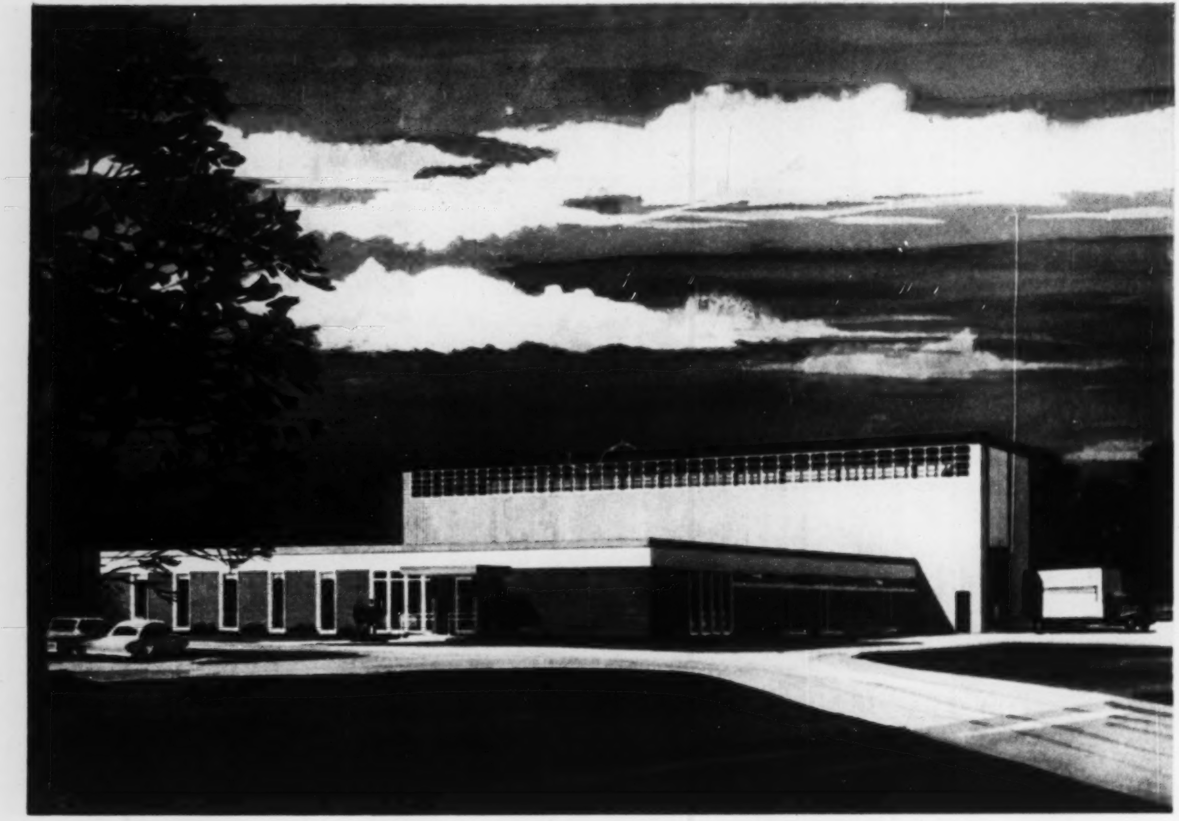

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